

Liquid Coating Compositions Having Improved Whiteness

FIELD OF THE INVENTION

5 The present invention relates to coating compositions, and more specifically, to liquid coating compositions containing toner polymers that incorporate thermally-stable copolymerizable toner dyes as an integral part of the polymer structure, resulting in coating compositions exhibiting improved whiteness and a reduction in the amount of yellowing that occurs upon exposure to heat and light.

10

BACKGROUND OF THE INVENTION

15 U.S. Pat. No. 5,384,377 discloses colored compounds which provide a toner system useful in imparting a desirable neutral to slightly blue hue to polyester fibers and plastics having a yellow appearance. The thermally stable colored compounds have reactive groups and can be incorporated into the polyester polymer structure during polymerization.

20 U.S. Pat. No. 5,340,910 discloses an improved process for the manufacture of blue anthraquinone toners in terms of quality, yield, economics, and safety and environmental concerns. The toners are taught to be useful in imparting improved whiteness to fiber-forming or moldable polyesters that normally appear yellow.

25

U.S. Pat. No. 4,745,174 discloses new fiber-forming or molding grade polyester compositions that exhibit improved apparent whiteness by having incorporated therein derivatives of dibenzoisoquinolinediones.

U.S. Pat. No. 5,372,864 discloses certain blue substituted anthraquinones in combination with selected red anthraquinone and anthrapyridone compounds which provide a toner system useful in imparting a desirable neutral to slightly blue hue to molding or fiber grade polyesters having a yellow appearance. The thermally stable colored compounds can have polyester reactive groups and are preferably incorporated into the polyester polymer structure during polymerization.

U.S. Pat. No. 5,688,899 discloses an improved clarity copolyester of a diethylene glycol modified poly(ethylene terephthalate) that incorporates color control agent residues derived from organic or inorganic toners.

U.S. Pat. No. 4,804,719 discloses water-dispersible polyesters and poly(ester-amides) containing water-solubilizing sulfonate groups and having reacted onto or into the polymer backbone relatively large amounts of a colorant comprising one or more heat stable organic compounds initially having one or more condensable groups. These colored polymers are said to be useful for printing inks or other coatings applied from an aqueous system.

Soviet Patent Application SU 1198084 A discloses diaminoanthraquinone derivatives as components of colored alkyd resins. The resulting resins are said to have a high color quality without requiring additional coloring operations.

European Patent Application 0 696 625 A2 discloses a method for reducing the yellowness of coating compositions comprising adding at least two dyes to a composition which, without the dyes, has an undesirable yellow color when dried.

SUMMARY OF THE INVENTION

One embodiment of the present invention provides liquid coating compositions, having improved whiteness, that contain a toner polymer, such as a polyester or an alkyd polymer, having polymerized therein a thermally-stable, copolymerizable toner dye as an integral part of the polymer structure. In one embodiment, the coating compositions contain one or more additional polymers that are subject to yellowing. In another embodiment, the toner polymer is itself a polymer subject to yellowing, and no additional polymer need be present.

In one embodiment, the toner polymer is a water-dispersible polymer that may serve as a surfactant or stabilizer added during an emulsion polymerization, or that may be later added to an aqueous coating composition during formulation. In another embodiment, the toner polymer is a solvent-borne polymer, that may be mixed with one or more additional polymers, in a solvent-borne coating composition. The various embodiments of the present invention are useful for improving the whiteness of coating compositions subject to yellowing, whether paint formulations, caulks, sealants, roof coatings, floor polishes, wall coatings, or the like. The current invention also leads to a reduction in the amount of color formation, upon exposure to heat and/or light, of such latexes, paint formulations, and other coatings.

25

DETAILED DESCRIPTION OF THE INVENTION

The present invention provides liquid coating compositions having improved whiteness and resistance to yellowing.

30

One aspect of the invention relates broadly to aqueous coating compositions. Coating compositions according to these embodiments contain water-dispersible (or water-dispersed) condensation polymers that have incorporated therein, thermally-stable, copolymerized toner dyes as
5 an integral part of the polymer structure.

In one aspect, the water-dispersible condensation polymer having one or more toner dyes polymerized therein is a water-dispersible polyester. As used herein, and as further defined below, the term polyester is intended to
10 encompass polyesters that include polyamide linkages. In another aspect, the water-dispersible condensation polymer having one or more toner dyes polymerized therein is a water-dispersible alkyd resin.

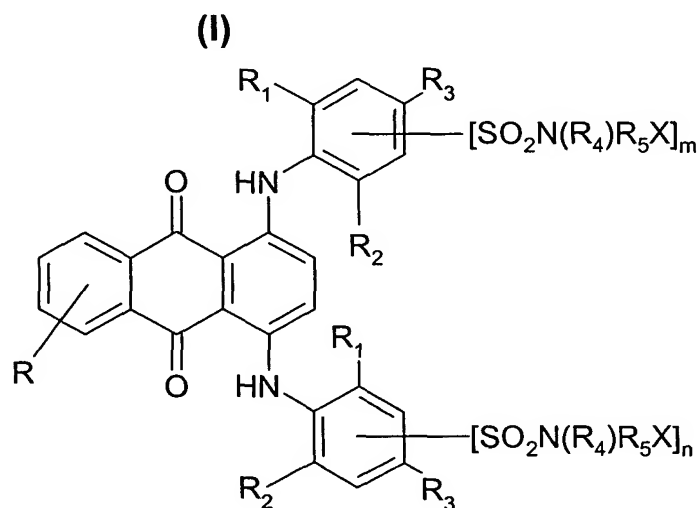
In one embodiment, the inventive coating compositions include: one or
15 more water-dispersible condensation polymers having incorporated therein one or more red or violet toner dyes and one or more blue toner dyes, wherein each dye can be in the same or a different water-dispersible polymer. Typically, the red toner dyes strongly absorb light at wavelengths from about 470 nm to about 580 nm, preferably from about 480 nm to about
20 570 nm, and all values within these ranges; the violet toner dyes typically absorb light at wavelengths from about 500 nm to about 610 nm, preferably from about 510 nm to about 600 nm, and all values within these ranges; and the blue toner dyes strongly absorb light at wavelengths from about 530 nm to about 650 nm, preferably from about 560 nm to about 640 nm,
25 and all values within these ranges.

In another aspect, the inventive coating compositions include one or more water-dispersible condensation polymers having incorporated therein one or more reddish-blue dyes that strongly absorb light at wavelengths of from
30 about 520 nm to about 630 nm, preferably from about 540 nm to about 620

nm, and all values within these ranges, and optionally, one or more red or violet toner dyes, each as defined herein.

In a further aspect, the inventive coating compositions comprise: a water-dispersible condensation polymer composition having copolymerized therein a toner dye system comprised of:

(1) at least one blue 1,4-bis(2,6-dialkylanilino)anthraquinone(s) of Formula (I):



10

wherein:

R is selected from the group consisting of hydrogen, C₁-C₆-alkyl, halogen, carboxy and C₁-C₆-alkoxycarbonyl;

R₁ and R₂ are independently selected from bromo and C₁-C₆-alkyl;

15

R₃ is selected from the group consisting of hydrogen, halogen, C₁-C₆-alkyl, substituted C₁-C₆-alkyl, hydroxy, C₁-C₆-alkoxy, substituted C₁-C₆-alkoxy, cyano, thiocyno, C₁-C₆-alkylthio, substituted C₁-C₆-alkylthio, C₁-C₆-alkylsulfonyl, substituted C₁-C₆-alkylsulfonyl, C₁-C₆-alkoxycarbonyl, carboxy, aryloxy, arylthio, arylsulfonyl, and SO₂N(R₄)R₅X when m and/or n are zero;

20

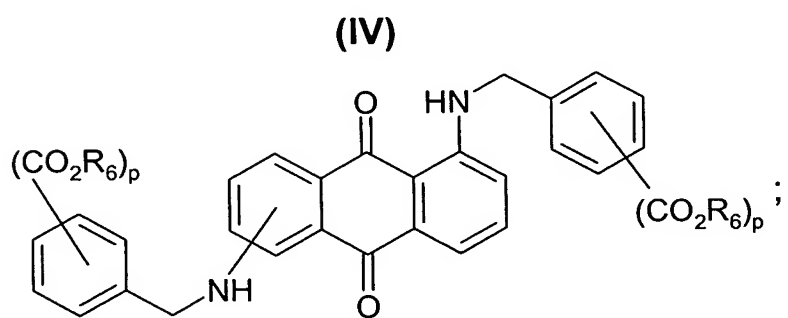
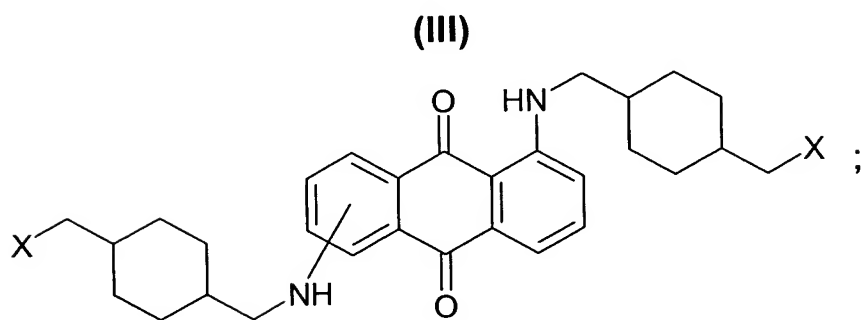
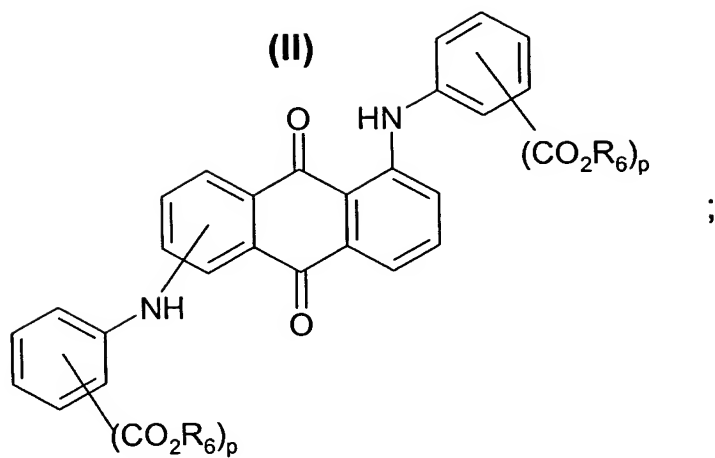
R₄ is selected from the group consisting of hydrogen, C₁-C₆-alkyl, substituted C₁-C₆-alkyl, C₃-C₈-alkenyl, C₃-C₈-alkynyl, C₃-C₈-cycloalkyl and aryl;

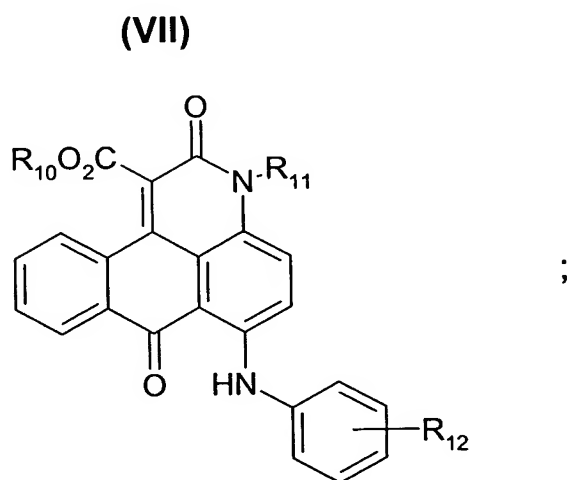
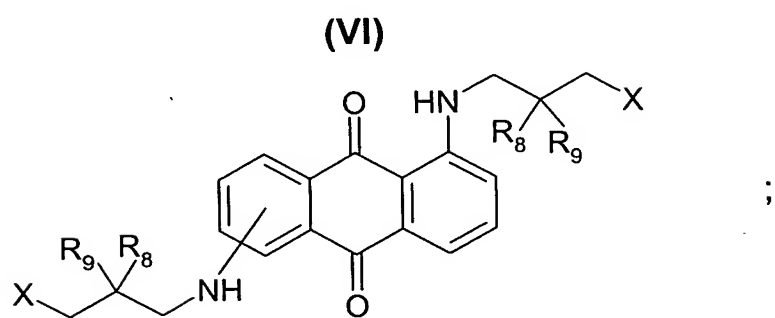
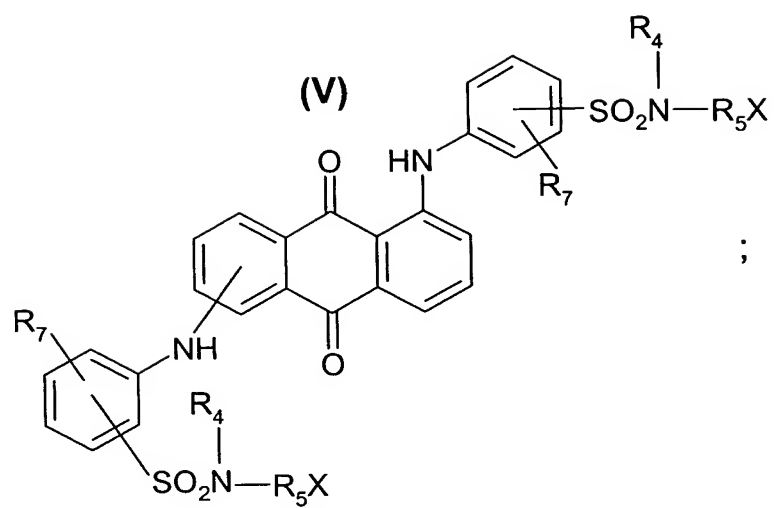
5 R₅ is a linking group selected from the group consisting of C₁-C₈-alkylene, C₁-C₆-alkylene-(Z-C₁-C₆)₁₋₂-alkylene, arylene-C₁-C₆-alkylene, arylene-Z-C₁-C₆-alkylene, C₃-C₇-cycloalkylene, C₁-C₆-alkylene-C₃-C₈-cycloalkylene-C₁-C₆-alkylene, C₁-C₆-alkylene-arylene-C₁-C₆-alkylene, and C₁-C₆-alkylene-Z-arylene-Z-C₁-C₆-alkylene, wherein Z is selected from -O-, -S- or SO₂ ;

10 X is hydrogen or a polyester reactive group; and
m and n are independently 0 or 1; with the proviso that at least one polyester reactive group is present;

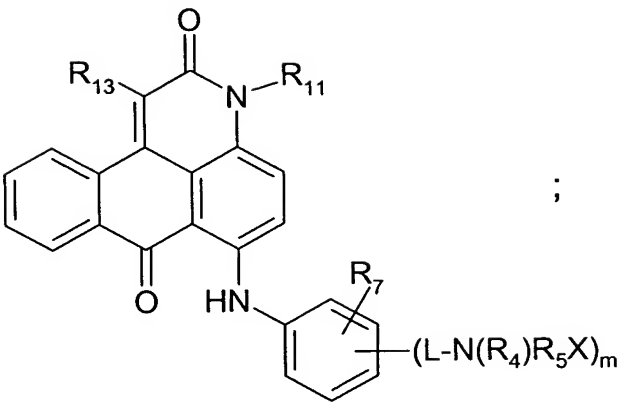
and

15 2) at least one red or violet toner dye, which may be blended with one or more of the blue component(s) of formula I above, and which has one of the following structural formulas II-X:

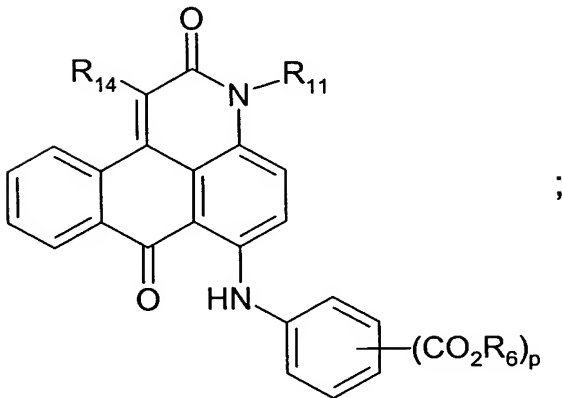




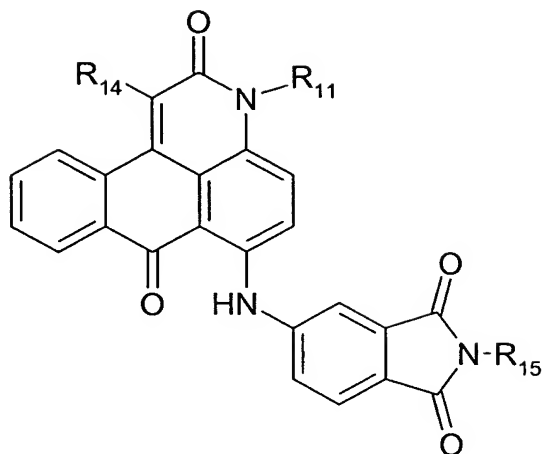
(VIII)



(IX)



(X)



wherein:

5 R_6 is selected from the group consisting of hydrogen, C_1 - C_6 -alkyl, substituted C_1 - C_6 -alkyl, C_3 - C_8 -alkenyl, C_3 - C_8 -alkynyl, C_3 - C_8 -cycloalkyl or aryl;

R_7 is hydrogen or one to three groups selected from C_1 - C_6 -alkyl, substituted C_1 - C_6 -alkyl, C_1 - C_6 -alkanoylamino, halogen, hydroxy, C_1 - C_6 -alkoxy, C_1 - C_6 -alkylthio, substituted C_1 - C_6 -alkoxy, substituted C_1 - C_6 -alkylthio;

10 R_8 and R_9 are the same or different and are selected from the group consisting of C_1 - C_6 -alkyl, substituted C_1 - C_6 -alkyl, C_3 - C_8 -cycloalkyl or aryl;

R_{10} is selected from the group consisting of C_1 - C_6 -alkyl, substituted C_1 - C_6 -alkyl, C_3 - C_8 -cycloalkyl or aryl;

15 R_{11} is selected from the group consisting of hydrogen, C_1 - C_{12} -alkyl, substituted C_1 - C_{12} -alkyl, C_3 - C_8 -alkenyl, C_3 - C_8 -alkynyl, C_3 - C_8 -cycloalkyl and aryl;

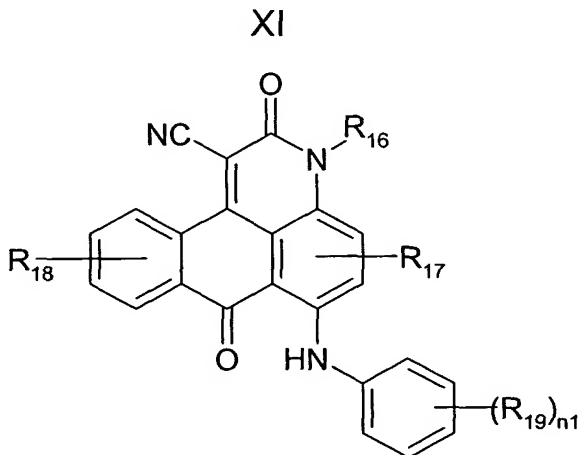
20 R_{12} is hydrogen or one to three groups selected from the group consisting of C_1 - C_6 -alkyl, substituted C_1 - C_6 -alkyl, C_1 - C_6 -alkoxy, substituted C_1 - C_6 -alkoxy, C_1 - C_6 -alkylthio, substituted C_1 - C_6 -alkylthio, halogen, hydroxy, C_1 - C_6 -alkanoylamino, aroylamino, C_1 - C_6 -alkylsulfonylamino and arylsulfonylamino;

R_{13} and R_{14} are selected from hydrogen, cyano or CO_2R_{10} ;

R_{15} is R_4 or R_5X as previously defined;

L is $-\text{CO}-$ or $-\text{SO}_2-$; X is as previously defined; m is 0 or 1; p is 1 or 2;
with the provision that at least one polyester reactive group is present as X
5 or as a substituent on R_3 , R_4 , R_6 , R_7 , R_{10} , R_{11} , R_{12} , R_{13} , R_{14} or R_{15} .

In a further embodiment, the inventive coating compositions comprise a
water-dispersible condensation polymer composition having copolymerized
therein at least one reddish-blue toner dye, optionally mixed with one or
10 more of the red or violet toner dyes set forth above in Formulae II-X, the
reddish-blue toner dye having a structure consistent with Formula (XI):



wherein

15 R_{16} is selected from hydrogen, $\text{C}_1\text{-C}_{12}$ -alkyl, substituted $\text{C}_1\text{-C}_{12}$ -alkyl, $\text{C}_3\text{-C}_8$ -cycloalkyl, $\text{C}_3\text{-C}_8$ -alkenyl, $\text{C}_3\text{-C}_8$ -alkynyl and aryl;

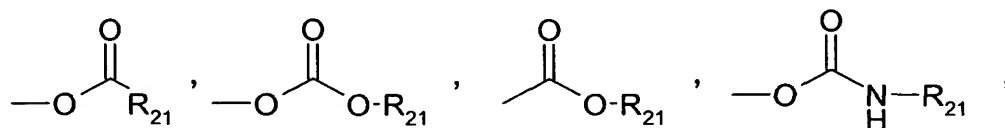
R_{17} is selected from hydrogen, halogen, $\text{C}_1\text{-C}_6$ -alkyl, substituted $\text{C}_1\text{-C}_6$ -alkyl, $\text{C}_1\text{-C}_6$ -alkoxy, substituted $\text{C}_1\text{-C}_6$ -alkoxy, aryloxy, $\text{C}_1\text{-C}_6$ -alkylthio, substituted $\text{C}_1\text{-C}_6$ -alkylthio, arylsulfonyl and arylthio;

20 R_{18} is selected from hydrogen, halogen, $\text{C}_1\text{-C}_6$ -alkyl, substituted $\text{C}_1\text{-C}_6$ -alkyl, $\text{C}_1\text{-C}_6$ -alkoxy and substituted $\text{C}_1\text{-C}_6$ -alkoxy;

R₁₉ is selected from hydrogen or 1-3 groups selected from, halogen, C₁-C₆-alkyl, substituted C₁-C₆-alkyl, aryl, C₁-C₆-alkoxy, substituted C₁-C₆-alkoxy, C₁-C₆-alkylthio, substituted C₁-C₆-alkylthio, C₁-C₆-alkoxycarbonyl, substituted C₁-C₆-alkoxycarbonyl, arylthio, C₁-C₆-alkoxycarbonyloxy, substituted C₁-C₆-alkoxycarbonyloxy, carboxy, sulfamoyl, C₁-C₆-alkyl-sulfamoyl, substituted C₁-C₆-alkylsulfamoyl, di-C₁-C₆-alkylsulfamoyl, substituted di-C₁-C₆-alkylsulfamoyl, C₁-C₆-alkylarylsulfamoyl, substituted C₁-C₆-alkylarylsulfamoyl, C₃-C₈-cycloalkylsulfamoyl, substituted C₃-C₈-cycloalkylsulfamoyl, arylsulfamoyl, carbamoyl, C₁-C₆-alkylcarbamoyl, substituted C₁-C₆-alkylcarbamoyl, di-C₁-C₆-alkylcarbamoyl, substituted di-C₁-C₆-alkylcarbamoyl, C₁-C₆-alkylarylcarbamoyl, substituted C₁-C₆-alkylarylcarbamoyl, C₃-C₈-cycloalkylcarbamoyl, substituted C₃-C₈-cycloalkylcarbamoyl, arylcarbamoyl, 2-pyrrolidono, C₁-C₆-alkanoylamino, substituted C₁-C₆-alkanoylamino, N-C₁-C₆-alkyl-C₁-C₆-alkanoylamino, or substituted N-C₁-C₆-alkyl-C₁-C₆-alkanoylamino; and

n₁ is an integer of 1 to 5; with the proviso that at least one polyester reactive group be present as X or as a substituent on R₁₆, R₁₇, R₁₈ or R₁₉.

The term "polyester reactive group" is used herein to describe a group which is reactive with at least one of the functional groups from which the polyester is prepared under polyester-forming conditions. Examples of the groups which X may represent include hydroxy, carboxy, an ester group, amino, C₁-C₆-alkylamino, etc. Thus, as used herein, the term polyester is intended to encompass polyesters that include polyamide linkages. The ester radicals may be any radical having the formulae



wherein R_{21} is selected from the group consisting of C_1 - C_6 -alkyl, substituted C_1 - C_6 -alkyl, C_3 - C_8 -cycloalkyl or aryl. Reactive group X is preferably hydroxy, carboxy, C_1 - C_2 -alkoxycarbonyl or acetoxy.

5 In the terms "substituted C_1 - C_6 -alkyl", "substituted C_1 - C_{12} -alkyl" "substituted C_1 - C_6 -alkoxy", "substituted C_1 - C_6 -alkylthio", "substituted C_1 - C_6 -alkylsulfonyl"
"substituted C_1 - C_6 -alkylsulfonylamido", "substituted alkylene", "substituted C_1 - C_6 -alkoxycarbonyl", "substituted C_1 - C_6 -alkoxycarbonyl", "substituted C_1 -
10 C_6 -alkoxycarbonyloxy", "substituted C_1 - C_6 -alkylsulfamoyl", "substituted di-
 C_1 - C_6 -alkylsulfamoyl", "substituted C_1 - C_6 -alkylarylsulfamoyl", "substituted C_3 - C_8 -cycloalkylsulfamoyl", "substituted C_1 - C_6 -alkylcarbamoyl", "substituted
di- C_1 - C_6 -alkylcarbamoyl", "substituted C_1 - C_6 -alkylarylsulfamoyl",
"substituted C_3 - C_8 -cycloalkylcarbamoyl", "substituted C_1 - C_6 -alkanoylamino"
and "substituted N- C_1 - C_6 -alkyl- C_1 - C_6 -alkanoylamino", the alkyl and alkylene
15 groups or portions of the groups may contain as further substituents one or
more groups, preferably one to three groups selected from the group
consisting of hydroxy, halogen, carboxy, cyano, aryl, aryloxy, arylthio, C_1 -
 C_4 -alkylthio, C_1 - C_4 -alkylthio, C_3 - C_7 -cycloalkyl, C_1 - C_4 -alkanoyloxy and -(O-
 R_{22} -) p_1 - R_{23} , wherein R_{22} is selected from the group consisting of C_1 - C_6 -
20 alkylene, C_1 - C_6 -alkylenearylene, cyclohexylene, arylene, and C_1 - C_6 -
alkylenecyclohexylene; R_{23} is selected from the group consisting of
hydrogen, hydroxy, carboxy, C_1 - C_4 -alkanoyloxy, C_1 - C_4 -alkoxycarbonyl, aryl,
and C_3 - C_7 -cycloalkyl; and p_1 is 1, 2, 3, or 4. The terms " C_1 - C_4 -alkanoyloxy"
and " C_1 - C_4 -alkoxycarbonyl" refer to the structures $R_{24}CO$ - and $R_{24}OCO$ -,
25 respectively, wherein R_{24} represents a straight or branched saturated
hydrocarbon radical containing one to four carbons.

The term "aryl" as used herein preferably denotes phenyl and phenyl
substituted with one to three substituents selected from the group
30 consisting of C_1 - C_6 -alkyl, C_1 - C_6 -alkoxy, halogen, carboxy, cyano, C_1 - C_6 -

alkylthio, C₁-C₆-alkylsulfonyl, trifluoromethyl, hydroxy, C₁-C₆-alkanoyloxy, C₁-C₆-alkanoylamino, and C₁-C₆-alkoxycarbonyl.

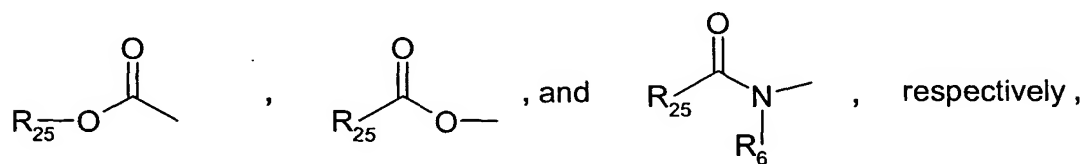
5 The term "arylene" includes 1,2-, 1,3- and 1,4-phenylene and such radicals substituted one to three times with C₁-C₆-alkyl, C₁-C₆-alkoxy, C₁-C₆-alkoxycarbonyl, or halogen.

10 The term "C₃-C₈-cycloalkyl" is used to denote saturated cycloaliphatic radicals containing three to eight carbon atoms.

The terms "C₃-C₈-alkenyl" and "C₃-C₈-alkynyl" are used to denote aliphatic hydrocarbon moieties having 3-8 carbons and containing at least one carbon-carbon double bond and one carbon-carbon triple bond, respectively.

15 The term "halogen" is used to indicate bromine, chlorine, fluorine, and iodine.

20 The terms "C₁-C₆-alkoxycarbonyl", "C₁-C₆-alkanoyloxy" and "C₁-C₆-alkanoylamino," consistent with their use throughout the specification, are used to represent radicals of the formulae



25 wherein R₂₅ is a straight or branched chain C₁-C₆-alkyl radical and R₆ is as defined above.

The terms "thermally stable" and "thermal stability" mean that the copolymerizable toner dyes can withstand the conditions of polyester

synthesis, as disclosed herein, without leading to a significant change in color that typically accompanies degradation of the toner dye chromophore, or a loss of color that can be due to volatilization of the toner dye.

5

The term "strongly absorb(s)" means that the toner dye has a maximum absorbance within the defined range. Preferably, the dye has a molar extinction coefficient, at the extremes of each of the respective specified ranges, that is greater than or equal to about 1/3, or preferably about 1/2, of the molar extinction coefficient at the wavelength of maximum absorbance, as defined by the Beer-Lambert Law (absorbance = extinction coefficient in unit of liters/(moles x cm) x path length in cm x concentration in molarity). Typically, the extinction coefficient at the extremes of each of the specified ranges is greater than or equal to about 4,000, in those cases where the extinction coefficient at the wavelength of maximum absorbance is from about 10,000 to about 25,000. The extinction coefficient as used herein is calculated using the Beer-Lambert Law from the absorbance of a homogeneous solution comprised of the dye in dimethylformamide, wherein the concentration of dye is adjusted such that the absorbance at the wavelength of maximum absorbance is in the range of from about 0.2 to about 1.5.

15

20

Where a range is specified, it is understood that all values within these ranges are within the scope of the present invention.

25

The inventive coating compositions may optionally be blended with one or more additional coating resins.

30

In a further embodiment, the water-dispersible polymers containing thermally-stable, copolymerizable toner dyes as an integral part of the

polymer structure are provided in an amount sufficient to enhance
whiteness and to prevent and mask yellowing, but yet not so much as to
visibly color the coating composition. In this regard, the toner dye or dyes
are provided in the coating composition in an amount of less than about 350
5 ppmw, based on the total weight of the coating composition, or within a
range from about 5 ppmw to about 80 ppmw, or from about 10 ppmw to
about 40 ppmw, and all values within these ranges.

Another aspect of the invention relates broadly to liquid coating
10 compositions that contain solvent-borne condensation polymers that have
incorporated therein, thermally-stable, copolymerized toner dyes as an
integral part of the polymer structure.

The term "solvent-borne" is intended to encompass those polymers
15 dispersed or dissolved in any organic solvent known to be useful in
formulating coating compositions, without limitation. Solvent-borne coating
compositions are distinguished from water-borne or aqueous coating
compositions by the fact that the predominant liquid present in the
composition is not water. Organic solvents suitable for use in formulating
20 coating compositions include, but are not limited to, benzene, xylene,
mineral spirits, vm&p naphtha, toluene, acetone, methyl ethyl ketone, methyl
n-amyl ketone, methyl isoamyl ketone, n-butyl acetate, isobutyl acetate, t-
butyl acetate, n-propyl acetate, isopropyl acetate, ethyl acetate, methyl
acetate, ethanol, n propanol, isopropanol, n butanol, sec butanol,
25 isobutanol, ethylene glycol monobutyl ether, propylene glycol n butyl ether,
propylene glycol methyl ether, propylene glycol monopropyl ether,
dipropylene glycol methyl ether, diethylene glycol monobutyl ether,
trimethylpentanediol mono isobutyrate, ethylene glycol mono octyl ether,
diacetone alcohol, TEXANOL ® ester alcohol (Eastman Chemical Co.), and
30 the like. Such solvents may also include reactive solvents, such as, for

example, diallyl phthalate, SANTOLINK XI 100 ® polyglycidyl allyl ether from Monsanto, and others as described in U.S. Patent Nos. 5,349,026 and 5,371,148, incorporated herein by reference.

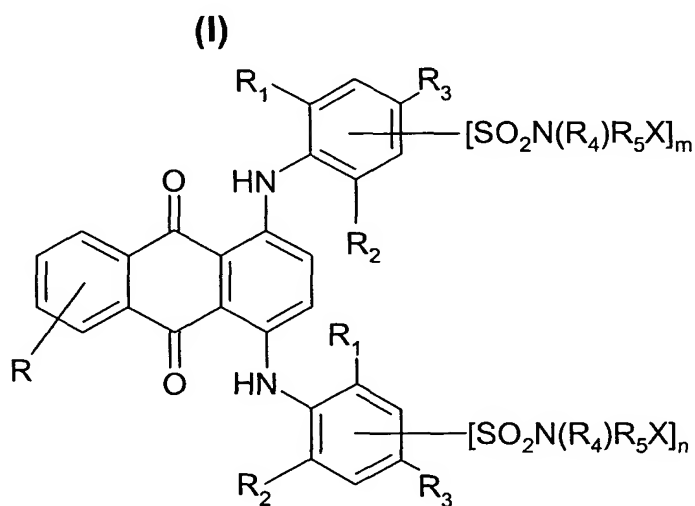
5 In one embodiment, the solvent-borne condensation polymer having toner dye polymerized therein is a solvent-borne polyester. As used herein, the term polyester is intended to encompass polyesters that include polyamide linkages. In another embodiment, the solvent-borne condensation polymer having one or more toner dyes polymerized therein is a solvent-borne alkyd
10 resin.

In one embodiment, the inventive coating compositions include: one or more solvent-borne polymers having incorporated therein one or more red or violet toner dyes and one or more blue toner dyes, wherein each dye can
15 be in the same or a different solvent-borne polymer. Typically, the red toner dyes strongly absorb light at wavelengths from about 470 nm to about 580 nm, preferably from about 480 nm to about 570 nm, and all values within these ranges; the violet toner dyes typically absorb light at wavelengths from about 500 nm to about 610 nm, preferably from about 510 nm to about
20 600 nm, and all values within these ranges; and the blue toner dyes strongly absorb light at wavelengths from about 530 nm to about 650 nm, preferably from about 560 nm to about 640 nm, and all values within these ranges.

25 In another aspect, the inventive coating compositions include one or more solvent-borne polymers having incorporated therein one or more reddish-blue dyes that strongly absorb light at wavelengths of from about 520 nm to about 630 nm, preferably from about 540 nm to about 620 nm, and all values within these ranges, and optionally, one or more red or violet toner
30 dyes, each as defined herein.

In a further aspect, the inventive coating compositions comprise: a solvent-borne polymer composition having copolymerized therein a toner dye system comprised of:

- 5 (1) at least one blue 1,4-bis(2,6-dialkylanilino)anthraquinone(s) of Formula (I):



wherein:

- 10 R is selected from the group consisting of hydrogen, C₁-C₆-alkyl, halogen, carboxy and C₁-C₆-alkoxycarbonyl;
- R₁ and R₂ are independently selected from bromo and C₁-C₆-alkyl;
- R₃ is selected from the group consisting of hydrogen, halogen, C₁-C₆-alkyl, substituted C₁-C₆-alkyl, hydroxy, C₁-C₆-alkoxy, substituted C₁-C₆-alkoxy, cyano, thiocyno, C₁-C₆-alkylthio, substituted C₁-C₆-alkylthio, C₁-C₆-alkylsulfonyl, substituted C₁-C₆-alkylsulfonyl, C₁-C₆-alkoxycarbonyl,
- 15 carboxy, aryloxy, arylthio, arylsulfonyl, and SO₂N(R₄)R₅X when m and/or n are zero;
- R₄ is selected from the group consisting of hydrogen, C₁-C₆-alkyl,
- 20 substituted C₁-C₆-alkyl, C₃-C₈-alkenyl, C₃-C₈-alkynyl, C₃-C₈-cycloalkyl and aryl;

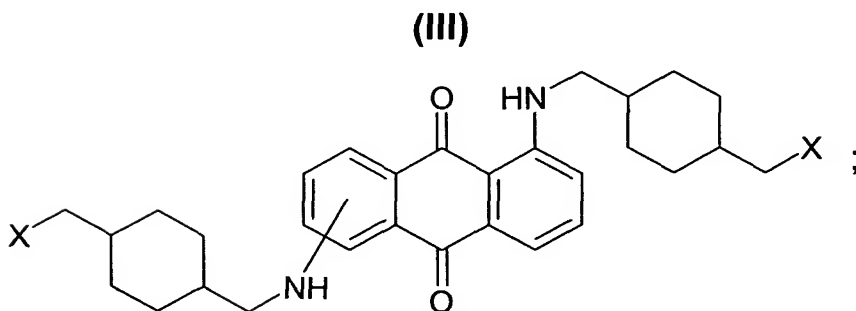
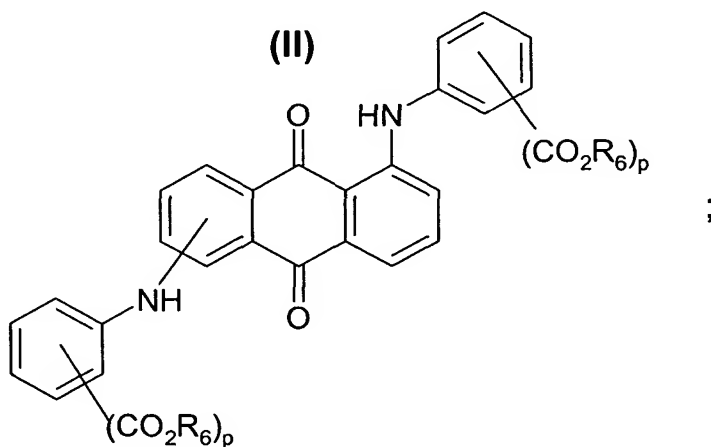
R_5 is a linking group selected from the group consisting of C_1 - C_8 -alkylene, C_1 - C_6 -alkylene-(Z - C_1 - C_6) $_{1-2}$ -alkylene, arylene- C_1 - C_6 -alkylene, arylene- Z - C_1 - C_6 -alkylene, C_3 - C_7 -cycloalkylene, C_1 - C_6 -alkylene- C_3 - C_8 -cycloalkylene- C_1 - C_6 -alkylene, C_1 - C_6 -alkylene-arylene- C_1 - C_6 -alkylene, and
 5 C_1 - C_6 -alkylene- Z -arylene- Z - C_1 - C_6 -alkylene, wherein Z is selected from $-O-$, $-S-$ or SO_2 ;

X is hydrogen or a polyester reactive group; and

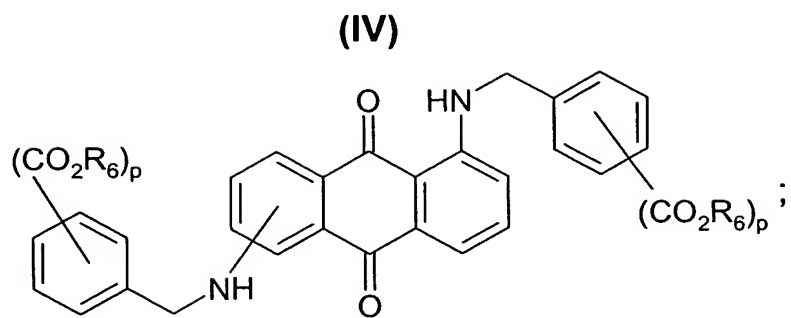
m and n are independently 0 or 1; with the proviso that at least one polyester reactive group is present;

10 and

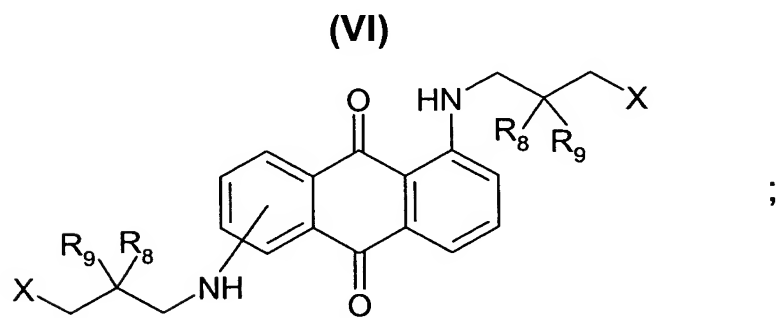
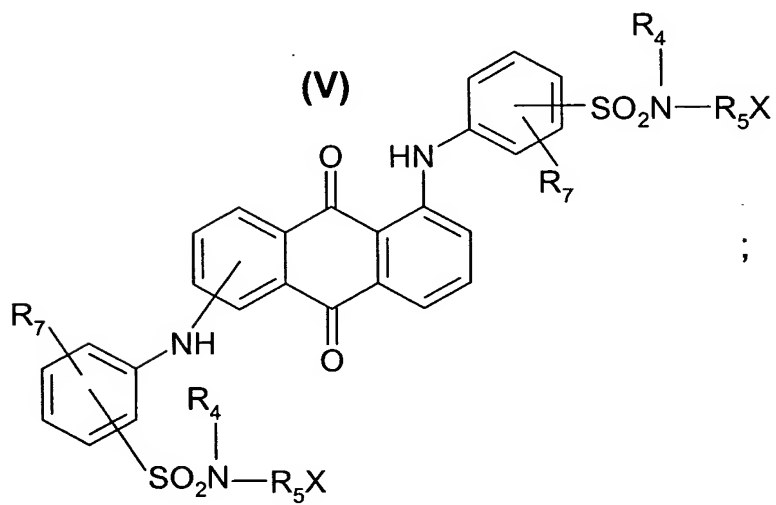
2) at least one red or violet toner dye, which may be blended with one or more of the blue component(s) of formula I above, and which has one of the following structural formulas II-X:



15

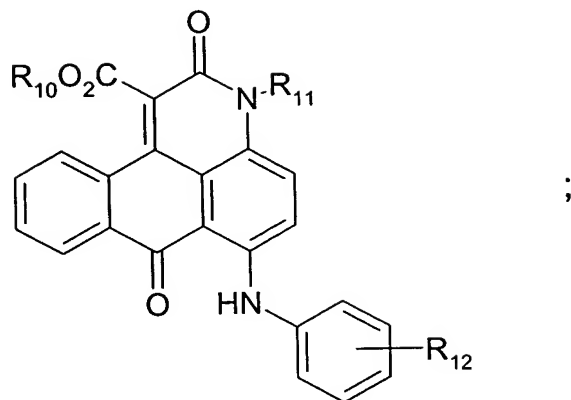


5

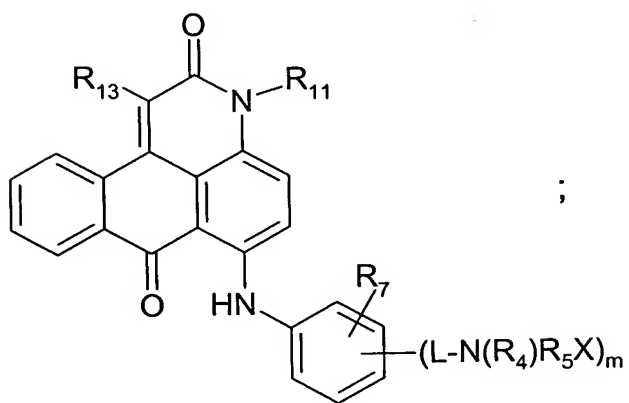


10

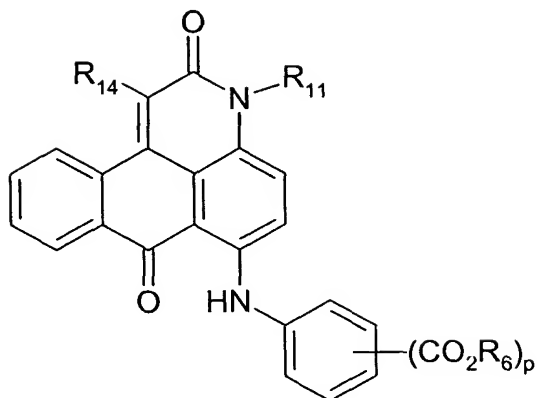
(VII)



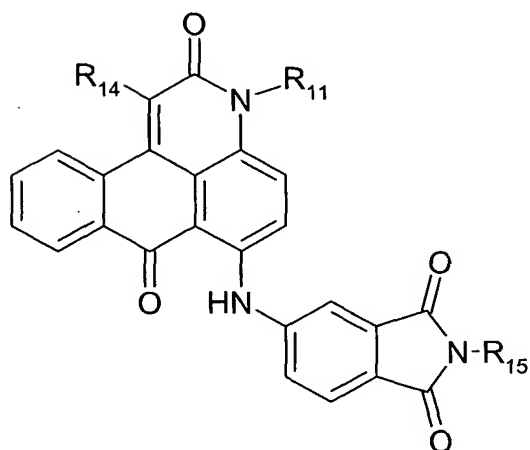
(VIII)



(IX)



(X)



wherein:

5 R₆ is selected from the group consisting of hydrogen, C₁-C₆-alkyl, substituted C₁-C₆-alkyl, C₃-C₈-alkenyl, C₃-C₈-alkynyl, C₃-C₈-cycloalkyl or aryl;

 R₇ is hydrogen or one to three groups selected from C₁-C₆-alkyl, substituted C₁-C₆-alkyl, C₁-C₆-alkanoylamino, halogen, hydroxy, C₁-C₆-alkoxy, C₁-C₆-alkylthio, substituted C₁-C₆-alkoxy, substituted C₁-C₆-alkylthio;

10

R_8 and R_9 are the same or different and are selected from the group consisting of C_1 - C_6 -alkyl, substituted C_1 - C_6 -alkyl, C_3 - C_8 -cycloalkyl or aryl;

R_{10} is selected from the group consisting of C_1 - C_6 -alkyl, substituted C_1 - C_6 -alkyl, C_3 - C_8 -cycloalkyl or aryl;

5 R_{11} is selected from the group consisting of hydrogen, C_1 - C_{12} -alkyl, substituted C_1 - C_{12} -alkyl, C_3 - C_8 -alkenyl, C_3 - C_8 -alkynyl, C_3 - C_8 -cycloalkyl and aryl;

10 R_{12} is hydrogen or one to three groups selected from the group consisting of C_1 - C_6 -alkyl, substituted C_1 - C_6 -alkyl, C_1 - C_6 -alkoxy, substituted C_1 - C_6 -alkoxy, C_1 - C_6 -alkylthio, substituted C_1 - C_6 -alkylthio, halogen, hydroxy, C_1 - C_6 -alkanoylamino, aroylamino, C_1 - C_6 -alkylsulfonylamino and arylsulfonylamino;

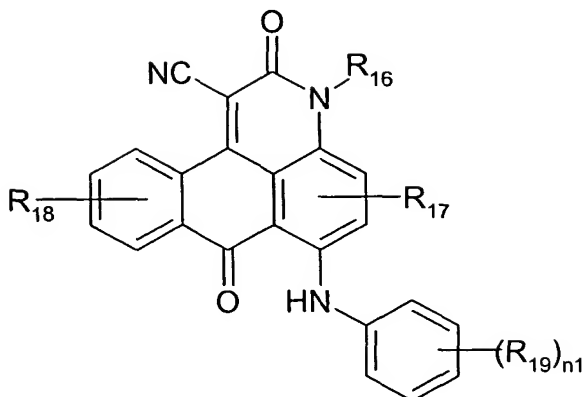
R_{13} and R_{14} are selected from hydrogen, cyano or CO_2R_{10} ;

R_{15} is R_4 or R_5X as previously defined;

15 L is $-CO-$ or $-SO_2-$; X is as previously defined; m is 0 or 1; p is 1 or 2; with the provision that at least one polyester reactive group is present as X or as a substituent on R_3 , R_4 , R_6 , R_7 , R_{10} , R_{11} , R_{12} , R_{13} , R_{14} or R_{15} .

20 In a further embodiment, the inventive coating compositions comprise a solvent-borne polymer composition having copolymerized therein at least one reddish-blue toner dye, optionally mixed with one or more of the red or violet toner dyes set forth above in Formulae II-X, the reddish-blue toner dye having a structure consistent with Formula (XI):

XI



wherein

R₁₆ is selected from hydrogen, C₁-C₁₂ alkyl, substituted C₁-C₆ alkyl, C₃-C₈ cycloalkyl, C₃-C₈ alkenyl, C₃-C₈ alkynyl and aryl;

5 R₁₇ is selected from hydrogen, halogen, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, C₁-C₆ alkoxy, substituted C₁-C₆ alkoxy, aryloxy, C₁-C₆ alkylthio, substituted C₁-C₆ alkylthio, arylsulfonyl and arylthio;

R₁₈ is selected from hydrogen, halogen, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, C₁-C₆ alkoxy and substituted C₁-C₆ alkoxy;

10 R₁₉ is selected from hydrogen or 1-3 groups selected from, halogen, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, aryl, C₁-C₆ alkoxy, substituted C₁-C₆ alkoxy, C₁-C₆ alkylthio, substituted C₁-C₆ alkylthio, C₁-C₆ alkoxy carbonyl, substituted C₁-C₆ alkoxy carbonyl, arylthio, C₁-C₆ alkoxy carbonyloxy, substituted C₁-C₆ alkoxy carbonyloxy, carboxy, sulfamoyl, C₁-C₆ alkyl-
15 sulfamoyl, substituted C₁-C₆ alkyl sulfamoyl, di-C₁-C₆ alkyl sulfamoyl, substituted di-C₁-C₆ alkyl sulfamoyl, C₁-C₆ alkyl aryl sulfamoyl, substituted C₁-C₆ alkyl aryl sulfamoyl, C₃-C₈ cycloalkyl sulfamoyl, substituted C₃-C₈ cycloalkyl sulfamoyl, aryl sulfamoyl, carbamoyl, C₁-C₆ alkyl carbamoyl, substituted C₁-C₆ alkyl carbamoyl, di-C₁-C₆ alkyl carbamoyl, substituted di-
20 C₁-C₆ alkyl carbamoyl, C₁-C₆ alkyl aryl carbamoyl, substituted C₁-C₆ alkyl aryl carbamoyl, C₃-C₈ cycloalkyl carbamoyl, substituted C₃-C₈ cycloalkyl carbamoyl, aryl carbamoyl, 2-pyrrolidono, C₁-C₆ alkanoylamino,

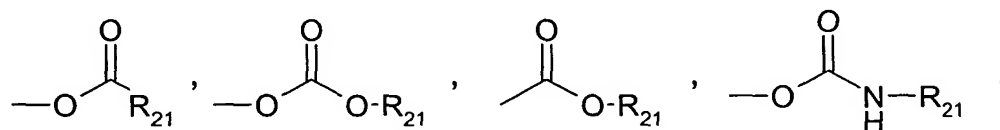
substituted C₁-C₆-alkanoylamino, N-C₁-C₆-alkyl-C₁-C₆-alkanoylamino, or substituted N-C₁-C₆-alkyl-C₁-C₆-alkanoylamino; and

n₁ is an integer of 1 to 5; with the proviso that at least one polyester reactive group be present as X or as a substituent on R₁₆, R₁₇, R₁₈ or R₁₉.

5

The term "polyester reactive group" is used herein to describe a group which is reactive with at least one of the functional groups from which the polyester is prepared under polyester-forming conditions. Examples of the groups which X may represent include hydroxy, carboxy, an ester group, amino, C₁-C₆-alkylamino, etc. Thus, as used herein, the term polyester is intended to encompass polyesters that include polyamide linkages. The ester radicals may be any radical having the formulae

10



15

wherein R₂₁ is selected from the group consisting of C₁-C₆-alkyl, substituted C₁-C₆-alkyl, C₃-C₈-cycloalkyl or aryl. Reactive group X is preferably hydroxy, carboxy, C₁-C₂-alkoxycarbonyl or acetoxy.

20

In the terms "substituted C₁-C₆-alkyl", "substituted C₁-C₁₂-alkyl" "substituted C₁-C₆-alkoxy", "substituted C₁-C₆-alkylthio", "substituted C₁-C₆-alkylsulfonyl" "substituted C₁-C₆-alkylsulfonylamido", "substituted alkylene", "substituted C₁-C₆-alkoxycarbonyl", "substituted C₁-C₆-alkoxycarbonyl", "substituted C₁-C₆-alkoxycarbonyloxy", "substituted C₁-C₆-alkylsulfamoyl", "substituted di-C₁-C₆-alkylsulfamoyl", "substituted C₁-C₆-alkylarylsulfamoyl", "substituted C₃-C₈-cycloalkylsulfamoyl", "substituted C₁-C₆-alkylcarbamoyl", "substituted di-C₁-C₆-alkylcarbamoyl", "substituted C₁-C₆-alkylarylcarmamoyl", "substituted C₃-C₈-cycloalkylcarbamoyl", "substituted C₁-C₆-alkanoylamino"

25

and "substituted N-C₁-C₆-alkyl-C₁-C₆-alkanoylamino", the alkyl and alkylene groups or portions of the groups may contain as further substituents one or more groups, preferably one to three groups selected from the group consisting of hydroxy, halogen, carboxy, cyano, aryl, aryloxy, arylthio, C₁-C₄-alkylthio, C₁-C₄-alkylthio, C₃-C₇-cycloalkyl, C₁-C₄-alkanoyloxy and $(-O-R_{22})_{p1}-R_{23}$, wherein R₂₂ is selected from the group consisting of C₁-C₆-alkylene, C₁-C₆-alkylenearylene, cyclohexylene, arylene, and C₁-C₆-alkylenecyclohexylene; R₂₃ is selected from the group consisting of hydrogen, hydroxy, carboxy, C₁-C₄-alkanoyloxy, C₁-C₄-alkoxycarbonyl, aryl, and C₃-C₇-cycloalkyl; and p₁ is 1, 2, 3, or 4. The terms "C₁-C₄-alkanoyloxy" and "C₁-C₄-alkoxycarbonyl" refer to the structures R₂₄CO- and R₂₄OCO-, respectively, wherein R₂₄ represents a straight or branched saturated hydrocarbon radical containing one to four carbons.

The term "aryl" as used herein preferably denotes phenyl and phenyl substituted with one to three substituents selected from the group consisting of C₁-C₆-alkyl, C₁-C₆-alkoxy, halogen, carboxy, cyano, C₁-C₆-alkylthio, C₁-C₆-alkylsulfonyl, trifluoromethyl, hydroxy, C₁-C₆-alkanoyloxy, C₁-C₆-alkanoylamino, and C₁-C₆-alkoxycarbonyl.

The term "arylene" includes 1,2-, 1,3- and 1,4-phenylene and such radicals substituted one to three times with C₁-C₆-alkyl, C₁-C₆-alkoxy, C₁-C₆-alkoxycarbonyl, or halogen.

The term "C₃-C₈-cycloalkyl" is used to denote saturated cycloaliphatic radicals containing three to eight carbon atoms.

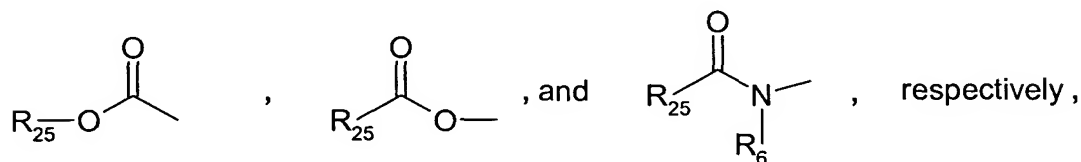
The terms "C₃-C₈-alkenyl" and "C₃-C₈-alkynyl" are used to denote aliphatic hydrocarbon moieties having 3-8 carbons and containing at least one

carbon-carbon double bond and one carbon-carbon triple bond, respectively.

5 The term "halogen" is used to indicate bromine, chlorine, fluorine, and iodine.

The terms "C₁-C₆-alkoxycarbonyl", "C₁-C₆-alkanoyloxy" and "C₁-C₆-alkanoylamino," consistent with their use throughout the specification, are used to represent radicals of the formulae

10



wherein R₂₅ is a straight or branched chain C₁-C₆-alkyl radical and R₆ is as defined above.

15 The terms "thermally stable" and "thermal stability" mean that the copolymerizable toner dyes can withstand the conditions of polyester synthesis, as disclosed herein, without leading to a significant change in color that typically accompanies degradation of the toner dye chromophore, or a loss of color that can be due to volatilization of the toner dye.

20

The term "strongly absorb(s)" means that the toner dye has a maximum absorbance within the defined range. Preferably, the dye has a molar extinction coefficient, at the extremes of each of the respective specified ranges, that is greater than or equal to about 1/3, or preferably about 1/2, of the molar extinction coefficient at the wavelength of maximum absorbance, as defined by the Beer-Lambert Law (absorbance = extinction coefficient in unit of liters/(moles x cm) x path length in cm x concentration in molarity). Typically, the extinction coefficient at the extremes of each of the specified

25

- ranges is greater than or equal to about 4,000, in those cases where the extinction coefficient at the wavelength of maximum absorbance is from about 10,000 to about 25,000. The extinction coefficient as used herein is calculated using the Beer-Lambert Law from the absorbance of a
- 5 homogeneous solution comprised of the dye in dimethylformamide, wherein the concentration of dye is adjusted such that the absorbance at the wavelength of maximum absorbance is in the range of from about 0.2 to about 1.5.
- 10 Where a range is specified, it is understood that all values within these ranges are within the scope of the present invention.
- The inventive coating compositions may optionally be blended with one or more additional coating resins, in addition to the solvent-borne toner
- 15 polymer, and the polymer subject to yellowing, if present.
- In one embodiment, the solvent-borne polymers containing thermally-stable, copolymerizable toner dyes as an integral part of the polymer structure are provided in an amount sufficient to enhance whiteness and to
- 20 prevent and mask yellowing, but yet not so much as to visibly color the coating composition. In this regard, the toner dye or dyes are provided in the coating composition in an amount of less than about 350 ppmw, based on the total weight of the coating composition, preferably within a range
- 25 from about 5 ppmw to about 80 ppmw, or from about 10 ppmw to about 40 ppmw, and all values within these ranges.

Water-dispersible and Solvent-Borne Polyester Compositions.

Descriptions and processes of manufacture of some exemplary water-dispersible polymer compositions that we have found to be suitable for
5 copolymerization with the copolymerized dyes used in various
embodiments of the invention described herein, are given in U.S. Pat. Nos.
3,734,874, 3,779,993, 3,828,010, 4,233,196, and 3,546,008, the
disclosures of which are incorporated herein by reference. As used herein,
and as further defined below, the term polyester is intended to encompass
10 polyesters that include polyamide linkages.

Solvent-borne polyester resins for use in various embodiments of the
present invention may be any polyester resin, with or without the hydrophilic
groups as described below, that may be dissolved in an organic solvent and
15 used in solvent-based coating formulations. Suitable polyesters include
those described in U.S. Pat. Nos. 3,668,276, 3,994,851, 4,535,132, and
4,316,940, the disclosures of which are incorporated herein by reference.
These polyesters may be combined with a curing agent capable of reacting
with active hydrogens in the polyester, to provide a thermosetting coating.
20 Examples of curing agents are aminoplasts and polyisocyanates, including
blocked isocyanates. A cure catalyst may also be employed.

An embodiment including a water-dispersible polyester resin may include
any waterborne polyester resin having at least one pendant hydrophilic
25 group or hydrophilic group that is part of the polymer backbone, such as
polyglycol ethers, that makes the polyester water-dispersible, as is known in
the art. Pendant hydrophilic groups include, but are not limited to, carboxylic
acids, sulfonic acids, polyglycol ethers, and the like.

Thus in one embodiment, the polyester polymers have linking groups comprising at least about 20 mole % carbonyloxy and up to about 80 mole % carbonylamido, said material containing water-solubilizing sulfonate groups and having reacted onto or into the polymer backbone from about 5 0.01 to about 30 weight %, based on the total weight of the polyester, wherein the toner dye initially has at least one polyester reactive group. The aforementioned equivalents encompass the various condensable derivatives thereof including hydroxy, carboxy, amino, C₁-C₆-alkoxycarbonyl, C₁-C₆-alkoxycarbonyloxy, C₁-C₆-N-alkylcarbamyloxy, C₁-10 C₆-alkanoyloxy, chlorocarbonyl, carbamyloxy, C₁-C₆-alkylamino, N-arylcarbamyloxy, cyclohexanoyloxy, and cyclohexyloxycarbonyl.

In one embodiment, the polymeric material contains carbonyloxy linking groups in the linear molecular structure, wherein up to 80% of said linking 15 groups may be carbonylamido linking groups, the polymer having an inherent viscosity of from about 0.1 to about 1.0 measured to a 60/40 parts by weight solution of phenol/tetrachloroethane at 25 °C. and at a concentration of 0.25 gram of polymer in 100 mL of the solvent, the polymer containing substantially equimolar proportions of acid equivalents (100 mole 20 percent) to hydroxy and amino equivalents (100 mole percent), the polymer comprising the reaction residues of the following reactants (a), (b), (c), (d), and (e) or the ester forming or esteramide forming derivatives thereof;

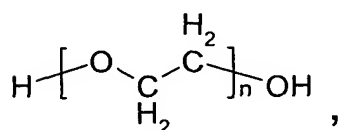
(a) at least one difunctional dicarboxylic acid;

(b) from about 4 to about 30 mole percent, based on a total of all 25 acid, hydroxyl and amino equivalents being equal to 200 mole percent, of at least one difunctional sulfomonomer containing at least one cationic sulfonate group attached to an aromatic or cycloaliphatic nucleus wherein the functional groups are hydroxy, carboxyl or amino;

(c) at least one difunctional reactant selected from a glycol or a 30 mixture of a glycol and a diamine having two -NHR₂₀ groups, wherein R₂₀ is

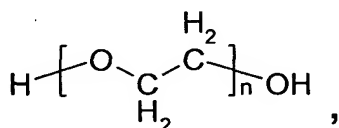
selected from hydrogen and C₁-C₁₂ alkyl, the glycol containing two -CH₂-OH groups of which

- 5 (1) at least 10 mole percent, based on the total mole percent of hydroxy or hydroxy and amino equivalents, is a poly(ethylene glycol) having the structural formula:



n being an integer of from 2 to about 20, or

- 10 (2) from none to less than about 15 mole percent based upon the total mole percent of hydroxy or hydroxy and amino equivalents, is a poly(ethylene glycol) having the structural formula:



15

n being an integer of between 20 and about 500, and with the proviso that the mole percent of said poly(ethylene glycol) within the range is inversely proportional to the quantity of *n* within said range;

- 20 (d) from none to at least one difunctional reactant selected from a hydroxycarboxylic acid having one -(C(R¹))₂-OH group, an amino-carboxylic acid having one -NR¹H group, and an amino-alcohol having one -(C(R¹))₂-OH group and one -NR¹H group, or mixtures of the difunctional reactants; wherein each R¹ in the (c) or (d) reactants is a hydrogen atom or an alkyl group of 1 to 4 carbon atoms; and

- 25 (e) from about 0.01 to about 30 weight % of one or more toner dye residue(s), based on the total weight of the polyester, wherein the toner dye

initially has at least one polyester reactive group comprising a blue anthraquinone toner dye and either a red or violet anthraquinone toner dye or a red or violet anthrapyridone toner dye or a single component colorant system comprising a reddish-blue anthrapyridone toner dye, and optionally
5 comprising a red or violet anthraquinone toner dye or a red or violet anthrapyridone toner dye, all as defined herein.

In the above polymeric material, it is preferred that very minor, e.g., less than about 10 mol % based on all reactants, of reactant (d) is employed,
10 that at least about 70 mol % of reactant (c) is glycol, and that at least about 70 mol % of all hydroxy equivalents is present in the glycol.

Those skilled in the art will readily appreciate that such polyesters may be provided in a liquid coating composition as a solvent-borne polymer, or may
15 be provided as a water-dispersed polyester, depending upon the characteristics of the particular polymer prepared, and the needs of the formulator.

In a further embodiment of the invention:

20 (A) the polyester material, that may be a water-dispersible polyester material, comprises (a) an acid component (moiety) of from about 75 to about 84 mole % isophthalic acid and conversely from about 25 to about 16 mole % 5-sodio-sulfoisophthalic acid, (c) a glycol component (moiety) of from about 45 to about 60 mole % diethylene glycol and conversely from
25 about 55 to about 40 mole % 1,4-cyclohexanedimethanol or ethylene glycol or mixtures thereof, and (e) from about 0.01 to about 30 weight %, preferably from about 0.05 weight % to about 10 weight %, of mono- or difunctional toner dye material based upon the total weight of the polyester; with regard to the polymer, the term "moiety" as used herein designates the
30 residual portion, for example, of the reactant acid or glycol or condensable

derivative thereof which actually enters into or onto the polymer chain during the condensation or polycondensation reaction;

(B) the inherent viscosity of the polymeric material is from about 0.20 to about 0.38, the acid component (moiety) comprises from about 80 to about 83 mole % isophthalic acid and conversely from about 20 to about 17 mole % 5-sodiosulfoisophthalic acid, and the glycol component (moiety) comprises from about 52 to about 56 mole % diethylene glycol and conversely from about 48 to about 44 mole % 1,4-cyclohexanedimethanol;

(C) the polyester materials have an inherent viscosity of from about 0.28 to about 0.38, an acid moiety of from about 75 to about 84 mole % isophthalic acid and conversely from about 25 to about 16 mole % 5-sodiosulfoisophthalic acid, and a poly(ethyleneglycol) moiety of from about 45 to about 60 mole % diethylene glycol and conversely from about 55 to about 44 mole % of a glycol component consisting of 1,4-cyclohexanedimethanol or ethylene glycol or mixtures thereof; and

(D) the acid moiety comprises from about 80 to about 83 mole % isophthalic acid and conversely from about 20 to about 17 mole % 5-sodiosulfoisophthalic acid, and the poly(ethyleneglycol) moiety comprises from about 52 to about 56 mole % diethylene glycol and conversely the glycol component comprises from about 48 to about 44 mole % 1,4-cyclohexanedimethanol.

The inherent viscosities (I.V.) of the particular polyester materials useful herein range from about 0.1 to about 1.0, determined according to ASTM D2857-70 procedure, in a Wagner Viscometer of Lab Glass, Inc. of Vineland N.J., having a 1/2 mL capillary bulb, using a polymer concentration about 0.25% by weight in 60/40 by weight of phenol/tetrachloroethane. The procedure is carried out by heating the polymer/solvent system at 120°C. for 15 minutes, cooling the solution to

25°C. and measuring the time of flow at 25°C. The I.V. is calculated from the equation:

$$(n)_{0.5\%}^{25^{\circ} \text{C}} = \ln \frac{t_s}{\frac{t_o}{C}}$$

5

wherein:

(n)=inherent viscosity at 25 °C. at a polymer concentration of 0.25 g/100 mL of solvent;

ln=natural logarithm;

10 t_s =sample flow time;

t_o =solvent-blank flow time; and

C=concentration of polymer in grams per 100 mL of solvent=0.25.

15 The units of the inherent viscosity throughout this application are in deciliters/gram. It is noted that higher concentrations of polymer, e.g., 0.50 g of polymer/100 mL solvent may be employed for more precise I.V. determinations.

20 The afore-described polyester material may be prepared according to the polyester preparation technology described in U.S. Pat. Nos. 3,734,874; 3,779,993; and 4,233,196, the disclosures of which are incorporated herein by reference, and the use of the term "acid" in the above description and in the appended claims includes the various ester-forming or condensable derivatives of the acid reactants such as the acid halides and dimethyl
25 esters as employed in the preparations set out in these patents. Among the sulfo-monomers selected are those wherein the sulfonate group is attached to an aromatic nucleus such as benzene, naphthalene, diphenyl, or the like,

or wherein the nucleus is cycloaliphatic such as in 1,4-cyclohexanedicarboxylic acid.

In another aspect, the polyester compositions further comprise a polyol.
5 Such polyesters are preferably formulated to have hydroxyl numbers 40-200 mg KOH/g, acid number 0-80 mg KOH/g, and number average molecular weight 800-3000. Examples of polyols include trimethylolpropane, trimethylolethane, glycerine, and pentaerythritol.

10 Water-Dispersible and Solvent-Borne Alkyd Compositions.

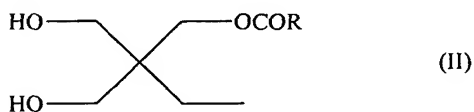
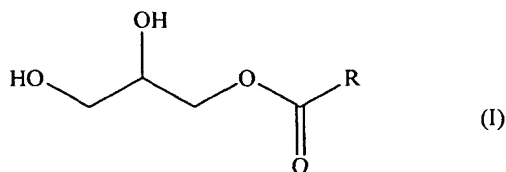
Alkyds useful in various embodiments of the invention may generally be prepared by reacting a diol, a polyol, a polyacid, a monofunctional acid, and a fatty acid, fatty ester, or a naturally occurring, partially-saponified oil,
15 optionally in the presence of a catalyst. In one embodiment, the alkyd resin portion of the toner polymer is prepared from: (i) from 0 to about 30 mol % of a diol, (ii) from about 10 to about 40 mol % of a polyol, (iii) from about 20 to about 40 mol % of a polyacid, (iv) from 0 to about 10 mol % of a monofunctional acid, (v) from about 10 to about 50 mol % of a fatty acid,
20 fatty ester, or naturally occurring oil, and optionally, (vi) a catalyst, wherein the mole percents are based on the total moles of (i), (ii), (iii), (iv), (v), and (vi), if present. Suitable examples of each of the components of the alkyd resin include those known in the art, including, but not limited to, those discussed below, and in Resins for Surface Coatings, Vol. 1, p. 127, ed. by
25 P.K.T. Oldring and G. Hayward, SITA Technology, London, UK, 1987, incorporated herein by reference.

A solvent-borne alkyd resin for use in various solvent-borne embodiments may be any alkyd resin with or without hydrophilic groups provided for

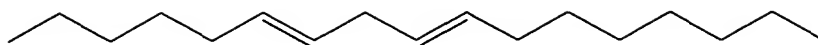
water-dispersibility, as described below. These resins may be dissolved in an organic solvent and used in solvent-based coating formulations.

5 The fatty acid, fatty ester, or naturally occurring, partially-saponified oil may be any fatty acid, fatty ester, or naturally occurring, partially-saponified oil known in the art used in the formation of an alkyd resin. In one embodiment, at least one monobasic fatty acid, fatty ester, or naturally occurring, partially-saponified oil is used and selected from the following formulae (I), (II) and (III):

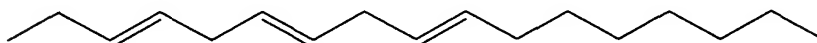
10



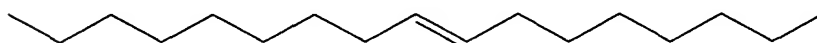
15 In formulae (I), (II) and (III), R is a saturated or unsaturated C₈-C₂₀ alkyl group. More preferably, R is one of the following unsaturated C₁₇ alkyl groups:



LINOLEIC



LINOLENIC



OLEIC

In another embodiment, the monobasic fatty acid or fatty ester oil may be prepared by reacting an oil or a fatty acid with a polyol. Examples of
5 suitable oils include sunflower oil, canola oil, dehydrated castor oil, coconut oil, corn oil, cottonseed oil, fish oil, linseed oil, oiticica oil, soya oil, tung oil, animal grease, castor oil, lard, palm kernel oil, peanut oil, perilla oil, safflower oil, tallow oil, walnut oil, and the like. Suitable examples of fatty acids alone or as components of oil include, but are not limited to, tallow
10 acid, soya acid, myristic acid, linseed acid, crotonic acid, versatic acid, coconut acid, tall oil fatty acid (e.g., PAMOLYN 200 and PAMOLYN 380, commercially available from Eastman Chemical Co.), rosin acid, neodecanoic acid, neopentanoic acid, isostearic acid, 12-hydroxystearic acid, cottonseed acid, and the like.

15

The polyol used in the preparation of the alkyd resin itself, or the monobasic fatty acid or fatty ester, is preferably selected from aliphatic, alicyclic and aryl alkyl polyols. Suitable examples of polyols include, but are not limited to, trimethylolpropane (TMP), pentaerythritol (PE), trimethyloethane, erythritol, threitol, dipentaerythritol, sorbitol, glycerine, and the like.
20 Preferably, the polyol is trimethylolpropane (TMP) or pentaerythritol (PE).

In addition to the polyol, a diol may be used in the preparation of the alkyd resin. Examples of suitable diols include, but are not limited to, neopentyl glycol (NPG), ethylene glycol, propylene glycol, diethylene glycol, triethylene glycol, tetraethylene glycol, pentaethylene glycol, hexaethylene glycol, heptaethylene glycol, octaethylene glycol, nonaethylene glycol, decaethylene glycol, 1,3-propanediol, 2,4-dimethyl-2-ethyl-hexane-1,3-diol, 2,2-dimethyl-1,2-propanediol, 2-ethyl-2-butyl-1,3-propanediol, 2-ethyl-2-isobutyl-1,3-propanediol, 1,3-butanediol, 1,4-butanediol, 1,5-pentanediol, 1,6-hexanediol, 2,2,4-tetramethyl-1,6-hexanediol, thiodiethanol, 1,2-cyclohexanedimethanol, 1,3-cyclohexanedimethanol, 1,4-cyclohexanedimethanol, 2,2,4-trimethyl-1,3-pentanediol, 2,2,4-tetramethyl-1,3-cyclobutanediol, p-xylenediol, hydroxypivalyl hydroxypivalate, 1,10-decanediol, and hydrogenated bisphenol A. Preferably, the diol is neopentyl glycol (NPG).

The polyacid (dicarboxylic acid or tricarboxylic acid) and monofunctional acid (monocarboxylic acid) components of the alkyd resin may be any polyacid or monofunctional acid known in the art used in the formation of an alkyd resin. The dicarboxylic acid may be, for example, isophthalic acid, phthalic anhydride (acid), terephthalic acid, adipic acid, tetrachlorophthalic anhydride, dodecanedioic acid, sebacic acid, azelaic acid, 1,4-cyclohexanedicarboxylic acid, 1,3-cyclohexanedicarboxylic acid, hexahydrophthalic anhydride, tetrahydrophthalic anhydride, maleic anhydride, fumaric acid, succinic anhydride, succinic acid, 2,6-naphthalenedicarboxylic acid, glutaric acid, and the like. Preferably, the dicarboxylic acid is isophthalic acid, phthalic anhydride, or phthalic acid. The tricarboxylic acid may be, for example, trimellitic anhydride. A monofunctional acid may also be used, such as, for example, benzoic acid, acetic acid, propionic acid, t-butylbenzoic acid, and butanoic acid.

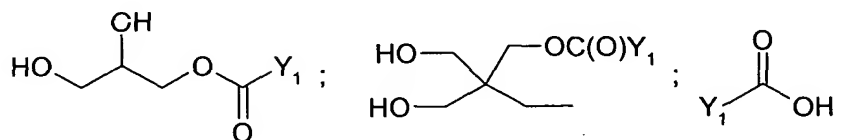
Optionally, a catalyst may be used to promote the formation of an alkyd resin. The catalyst may be any catalyst known in the art to be used in the formation of an alkyd resin. Preferably, the catalyst is an acid catalyst, such as, for example, FASCAT 4100. The amount of catalyst added promotes the formation of an alkyd resin as described above, and may be determined by routine experimentation as understood by those skilled in the art. Preferably, a catalyst is added in amounts ranging from about 0.01-1.00 wt %, based on the amounts of reactants.

An alkyd resin may be prepared at a temperature range of about 170-250°C. In a specific embodiment, an alkyd resin has an acid number of from about 2 to about 9mg KOH/g, or from about 3 to about 9mg KOH/g, or from about 3 to about 7mg KOH/g, or from about 4 to about 7mg KOH/g. The alkyd resin has a preferred number average molecular weight of from about 700 to about 6500, more specifically from about 1000 to about 3500, and a T_g of less than about 25°C.

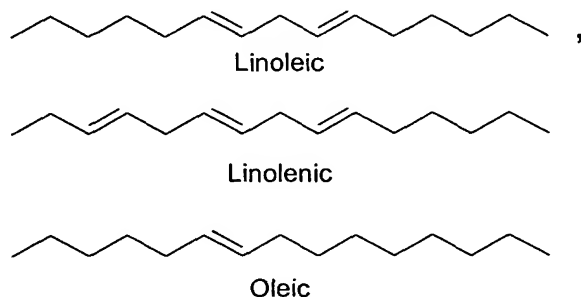
A water-dispersible alkyd resin for use in the present invention may be any alkyd resin having at least one hydrophilic group that makes the alkyd water-dispersible, as is known in the art. Hydrophilic groups include, but are not limited to, carboxylic acids, sulfonic acids, polyglycol ethers, and the like. Examples of such alkyd resins are described in U.S. Pat. No. Nos. 5,378,757 and 5,530,059, the disclosures of which are incorporated herein by reference.

Generally, sulfonated waterborne alkyd resins may be prepared by reacting a monobasic fatty acid, fatty ester or a naturally-occurring, partially-saponified oil; a glycol or polyol; a polycarboxylic acid; and a sulfomonomer or sulfomonomer adduct containing at least one sulfomonomer group.

The monobasic fatty acid, fatty ester, or naturally-occurring, partially-saponified oil is preferably selected from the formulae below:



5 wherein Y_1 is a C_8 - C_{20} alkyl or alkenyl group. More preferably, Y_1 is selected from one of the following:



10 The monobasic fatty acid, fatty ester or naturally-occurring, partially-saponified oil is preferably prepared by reacting a fatty acid or oil with a polyol. Examples of suitable oils include, but are not limited to, sunflower oil, canola oil, dehydrated castor oil, coconut oil, corn oil, cottonseed oil, fish oil, linseed oil, oiticica oil, soya oil, and tung oil, animal grease, castor oil, lard, palm kernel oil, peanut oil, perilla oil, safflower oil, tallow oil, walnut oil, and the like. Suitable examples of fatty acids alone or as components of oil

15 include, but are not limited to, tallow acid, soya acid, myristic acid, linseed acid, crotonic acid, versatic acid, coconut acid, tall oil fatty acid, rosin acid, neodecanoic acid, neopentanoic acid, isostearic acid, 12-hydroxystearic acid, cottonseed acid, and the like.

20 The glycol is preferably selected from aliphatic, alicyclic, and aryl alkyl glycols. Suitable examples of glycols include, but are not limited to,

ethylene glycol, propylene glycol, 1,3-propanediol, 2,4-dimethyl-2-ethyl-
hexane-1,3-diol, 2,2-dimethyl-1,3-propanediol, 2-ethyl-2-butyl-1,3-
propanediol, 2-ethyl-2-isobutyl-1,3-propanediol, 1,3-butanediol, 1,4-
butanediol, 1,5-pentanediol, 1,6-hexanediol, 2,2,4-tetramethyl-1,6-
5 hexanediol, 1,2-cyclohexanedimethanol, 1,3-cyclohexanedimethanol,
1,4-cyclohexanedimethanol, 2,2,4-trimethyl-1,3-pentanediol, 2,2,4-
tetramethyl-1,3-cyclobutanediol, p-xylenediol, hydroxypivalyl
hydroxypivalate, 1,10-decanediol, 2,6-decahydronaphthalenedimethanol
hydrogenated bisphenol A. Suitable poly(ethylene glycols) include but are
10 not limited to the following: diethylene glycol, triethylene glycol,
tetraethylene glycol, pentaethylene glycol, hexaethylene glycol,
heptaethylene glycol, octaethylene glycol, nonaethylene glycol, deca-
ethylene glycol. Suitable polyols include but are not limited to the following:
trimethylolpropane, trimethylolethane, pentaerythritol, erythritol, threitol,
15 dipentaerythritol, sorbitol, glycerine, and the like.

Suitable carboxylic acids include, but are not limited to, those selected from
the group consisting of isophthalic acid, terephthalic acid, phthalic
anhydride(acid), adipic acid, tetrachlorophthalic anhydride,
20 tetrahydrophthalic anhydride, acid trimellitic anhydride, pyromellitic
dianhydride, dimethylolpropionic acid, dodecanedioic acid, sebacic acid,
azelaic acid, 1,4-cyclohexanedicarboxylic acid, 1,3-cyclohexanedicarboxylic
acid, 2,6-decahydronaphthalenedicarboxylic acid, maleic anhydride, fumaric
acid, succinic anhydride(acid), 2,6-naphthalenedicarboxylic acid, glutaric
25 acid, and esters thereof.

The sulfonated waterborne alkyd resins useful in the invention preferably
have a K value, defined as the total number of moles (M_t) of each reactant
divided by the total equivalents of acid functionality (E_a), of about 1.0 to
30 about 1.5, more preferably of about 1.0 to about 1.25, and an R value,

defined as the total equivalents of hydroxyl functionality (E_{OH}) divided by the total equivalents of acid functionality (E_a), of about 1.0 to about 2.0, more preferably of about 1.0 to about 1.5.

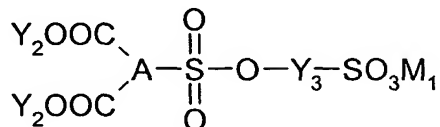
- 5 The K value is a measure of a resin's molecular weight, which increases as the K value decreases to 1.00. Since higher molecular weight resins are better, K values that are closer to 1.00 are most preferred. The R value is proportional to the excess equivalents of hydroxyl functionality used in the resin synthesis. An excess of hydroxyl functionality is preferred, however
10 this excess should not be so high as to render the resulting coating water sensitive.

- The sulfomonomer of the sulfomonomer adduct is either a difunctional or a monofunctional monomer containing a $-SO_3M$ group attached to an
15 aromatic nucleus where M is hydrogen or a metal ion such as, for example, Na^+ , Li^+ , K^+ , Ca^{2+} , Cu^{2+} , Fe^{2+} , or Fe^{3+} . The sulfomonomer as a difunctional monomer component may be a dicarboxylic acid (or a derivative thereof) containing a $-SO_3M$ group where M is as defined above. Suitable examples of the aromatic nucleus to which the $-SO_3M$ group may be attached include,
20 but are not limited to, benzene, naphthalene, anthracene, diphenyl, oxydiphenyl, sulfonyl-diphenyl, and methylenediphenyl.

- Especially good results are obtained when the difunctional monomer is a sodium salt of a sulfoisophthalic acid, a sulfoterephthalic acid, a
25 sulfophthalic acid, a 4-sulfo-naphthalene-2,7-dicarboxylic acid or a derivative thereof. In a specific embodiment, the difunctional monomer is 5-sodiosulfoisophthalic acid or a derivative such as dimethyl 5-sodiosulfoisophthalate. Other preferred difunctional monomers are lithium 5-sulfoisophthalic acid, dimethyl lithium 5-sulfoisophthalate, potassium 5-sulfoisophthalic acid, and dimethyl potassium 5-sulfoisophthalate.
30

Other effective difunctional monomers containing a $-\text{SO}_3\text{M}$ group attached to an aromatic nucleus include metal salts of aromatic sulfonic acids or their respective esters of the formula:

5

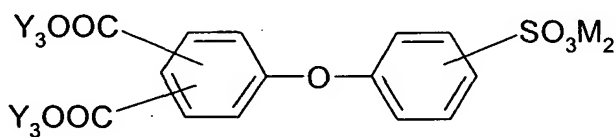


wherein A is a trivalent aromatic hydrocarbon radical, Y_2 is hydrogen or an alkyl group of one to four carbon atoms, Y_3 is a divalent aromatic hydrocarbon radical, M_1 is hydrogen, Na^+ , Li^+ , or K^+ . Examples of preferred monomers include, but are not limited to, 4-sodiosulphophenyl-3,5-dicarbomethoxybenzenesulfonate, 4-lithiosulphophenyl-3,5-dicarbomethoxybenzenesulfonate and 6-sodiosulfo-2-naphthyl-3,5-dicarbomethoxybenzenesulfonate.

15

Still other effective difunctional monomers containing a $-\text{SO}_3\text{M}$ group attached to an aromatic nucleus include metal salts of sulfodiphenyl ether dicarboxylic acids or esters thereof of the formula below:

20



wherein Y_3 is hydrogen, an alkyl group of one to eight carbon atoms, or phenyl and M_2 is hydrogen, K^+ , Na^+ , or Li^+ . Examples of preferred monomers include, but are not limited to, dimethyl 5-[4-(sodiosulfo)phenoxy]isophthalate, dimethyl 5-[4-

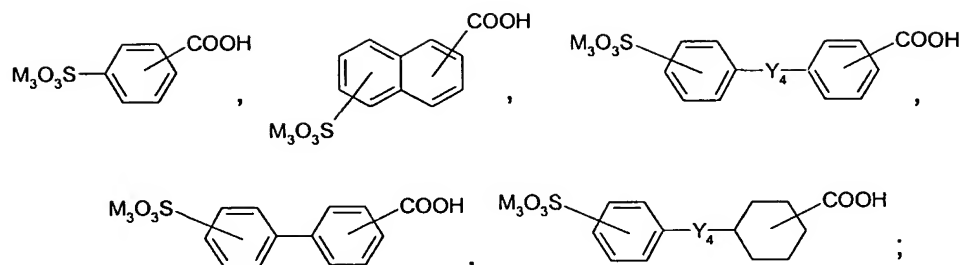
25

(sodiosulfo)phenoxy]terephthalate, and 5-[4-(sodiosulfo)phenoxy]isophthalic acid. Additional examples of such monomers are disclosed in U.S. Pat. No. 3,734,874, incorporated herein by reference.

5 The type and amount of metal sulfonate selected for water-dispersibility can be varied to obtain useful ion-containing alkyd resins. As little as 2 mole percent based on total carboxylic acid content will impart a significant degree of water miscibility; however, at least 3 percent is preferred. Water-soluble polyesters can be formulated with as much as 20 mole percent of
10 the metal sulfonate. However, a practical upper limit based on the amount of branch-inducing intermediate required to counteract the water sensitivity effects is 9 percent, preferably 6 percent.

15 Metal sulfonates that are most preferred include 5-sodiosulfoisophthalic acid, dimethyl 5-sodiosulfoisophthalate, lithium 5-sulfoisophthalic acid, dimethyl lithium 5-sulfoisophthalate, potassium 5-sulfoisophthalic acid, dimethyl potassium 5-sulfoisophthalate, 3-sodiosulfbenzoic acid and the like.

20 Optionally, the sulfomonomer containing at least one sulfonate group that may be reacted with a polyol to produce a polyol (e.g. a diol) sulfomonomer adduct may be a monofunctional sulfomonomer containing at least one sulfonate group that may be reacted with a polyol containing at least three hydroxyl groups. The monofunctional sulfomonomer is preferably selected
25 from the following group of sulfomonomers:



where Y_4 is CH_2 , SO_2 , or O and M_3 is an alkaline or alkaline earth metal.

5

The polyol sulfomonomer adduct is prepared by reacting a difunctional sulfomonomer with a glycol, poly(ethylene glycol), or a polyol. Suitable examples of diols include those described above with the following diols being more preferred: ethylene glycol, diethylene glycol, 2,2,4-trimethyl-1,3-pentenediol, 1,4-cyclohexanedimethanol, 1,3-cyclohexanedimethanol, hydroxypivalyl hydroxypivalate, dipropylene glycol, 1,6-hexanediol, 1,10-decahydronaphthalenediol, 2,6-decahydro-naphthalenedimethanol, 1,3-butanediol, hydrogenated bisphenol A, 1,4-butanediol and neopentyl glycol.

10

15

In addition to the amount of polyol reacted with the fatty acid, fatty ester, or naturally-occurring, partially-saponified oil according to the preferred step, and in addition to the polyol used in the preparation of the sulfomonomer adduct from a monofunctional sulfomonomer, an additional amount of a polyol or other branching agent such as a polycarboxylic acid may be used to increase the molecular weight and branching of the waterborne alkyd resin. These branching agents are preferably selected from trimethylolethane, pentaerythritol, erythritol, threitol, dipentaerythritol, sorbitol, glycerine, trimellitic anhydride, pyromellitic dianhydride, dimethylolpropionic acid, and trimethylolpropane.

20

25

Latex Polymer Compositions.

The vinyl, or latex, polymers present in various embodiments, and that are subject to yellowing, are copolymers of ethylenically unsaturated monomers. Useful comonomers are simple olefins such as ethylene, alkyl acrylates, and methacrylates, where the alkyl group has 1 to 20 carbon atoms (more preferably 1 to 8 carbon atoms), vinyl acetate, acrylic acid, methacrylic acid, acrylonitrile, styrene, isobornyl methacrylate, acrylamide, hydroxyethyl acrylate and methacrylate, hydroxypropyl methacrylate and acrylate, N-vinyl pyrrolidinone, butadiene, isoprene, vinyl halides such as vinyl chloride and vinylidene chloride, alkyl maleates, alkyl fumarates, fumaric acid, maleic acid, itaconic acid, etc. It is also possible and sometimes desirable to include low levels of divinyl or polyvinyl monomers such as glycol polyacrylates, allyl methacrylate, divinyl benzene, etc. to introduce a controlled amount of gel in the latex particle.

Polymers having a molecular weight of from 1000 to over one million can be used.

Generally, the vinyl polymer is prepared as a dispersion or emulsion polymer in water by a suitable free radical initiated polymerization technique, using a free radical initiator and appropriate heating.

As an emulsifier, an anionic, nonionic, or anionic-nonionic emulsifying agent can be used. Examples of anionic emulsifiers include sodium higher alcohol sulfates, sodium alkylbenzenesulfonates, sodium dialkyl succinic acid sulfonates, and sodium alkyl-diphenyl ether disulfonates. Of these, preferable anionic emulsifiers are sodium dodecylbenzenesulfonate, sodium lauryl sulfate, and sulfate of polyoxyethylene alkyl (or alkylphenyl) ether. As examples of nonionic emulsifiers, polyoxyethylene alkylaryl ether

can be given. Usually, polyoxyethylene nonylphenyl ether, polyoxyethylene octylphenyl ether, or the like is used as a nonionic emulsifier.

5 Furthermore, a reactive emulsifier that can copolymerize with the ethylenically unsaturated monomers can be used in the preparation of aqueous copolymer latexes of the present invention. Examples of such reactive emulsifiers are sodium styrene sulfonate, sodium allylalkyl sulfonates, alkylallyl sulfosuccinates, polyoxyethylene alkylallyl glycerine ether sulfates, polyoxyethylene alkylphenol allylglycerine ether sulfates, and
10 the like.

A water-soluble high molecular weight compound may also be used as an emulsifier or stabilizer. Given as examples of the water-soluble high molecular compounds are polyvinyl alcohols, polyacrylates, water-soluble
15 (meth)acrylate copolymers, salts of styrene-maleic acid copolymers, salts of styrene(meth)acrylic acid copolymers, copolymers of poly(meth)acryl amide, and copolymers of poly(meth)acryl amide. Of these, preferable water-soluble high molecular weight compounds are partially saponified polyvinyl alcohols, water-soluble (meth)acrylate copolymers, salts of
20 carboxylated aromatic vinyl copolymer, e.g., salts of styrene-maleic acid copolymer, salts of styrene-(meth)acrylic acid copolymer; and the like.

Additional high molecular weight emulsifiers or stabilizers that are suitable in the present invention are the various water-dispersible toner polymers
25 described herein.

As the aforementioned polymerization initiator, for example, water-soluble persulfates and hydrogen peroxide, preferably ammonium, sodium, or potassium persulfate, can be used, and these compounds may be used in
30 combination with a reducing agent.

Given as examples of reducing agents are sodium pyrosulfite, sodium hydrogensulfite, sodium thiosulfate, erythorbic acid, L-ascorbic acid and salts thereof, sodium formaldehyde sulfoxylate, and the like.

5

In addition, an oil soluble polymerization initiator such as, for example, 2,2'-azobis-isobutyronitrile, 2,2'-azobis (4-methoxy-2,4-dimethylvaleronitrile), 2,2'-azobis-2,4-dimethylvaleronitrile, 1,1'-azobis- cyclohexane-1-carbonitrile, benzoyl peroxide, dibutyl peroxide, and cumene hydroperoxide, or the like, may be used dissolved in the monomer or the medium.

10

Particular oil soluble polymerization initiators are cumen hydroperoxide, isopropylbenzene hydroperoxide, azobisisobutyronitrile, benzoyl peroxide, tert-butyl hydroperoxide, 3,5,5-trimethylhexanol peroxide, and tertbutylperoxy(2-ethylhexanoate). About 0.1 to 3 parts by weight of such a copolymerization initiator is used for 100 parts of the ethylenically unsaturated monomers.

15

Given as examples of the aforementioned chain transfer agents are halogenated hydrocarbons, e.g., chloroform, bromoform; mercaptans, e.g., n-dodecyl mercaptan, tertdodecyl mercaptan, n-octyl mercaptan; alkyl mercapto propionates, xanthogenic compounds, e.g., dimethylxanthogen disulfide, diisopropylxanthogen disulfide; terpenes, e.g., dipentene, terpinolene; α -methylstyrene dimers (those consisting of at least one of 2,4-diphenyl-4-methyl-1-pentene (a_1), 2-4-diphenyl-4-methylphenylpentene (a_2), and 1-1-3-trimethyl-3-phenylindane (a_3), and preferably those with the ratio by weight of (a_1)/(a_2) and/or (a_3) being 40-100/0-60); unsaturated cyclic hydrocarbons, e.g., 9,10-dihydroanthracene, 1,4-dihydronaphthalene, indene, and 1,4-cyclohexadiene; unsaturated heterocyclic compounds, e.g., xanthene and 2,5-dihydrofuran; and octyl thioglycolate, preferably α -methylstyrene dimmer, and the like. The chain transfer agent is added in

20

25

30

an amount of approximately 0 to 5 parts by weight per 100 parts of the ethylenically unsaturated monomers.

Examples of the aforementioned chelating agents are glycine, alanine, ammonium carbonate, ethylenediamine tetraacetate, preferably ammonium carbonate. As a pH modifier, sodium carbonate, potassium carbonate, sodium bicarbonate, ammonia, preferably ammonia, can be used. The chelating agent and the pH modifier are compounded in an amount of approximately 0 to 0.1 and 0 to 3 parts by weight, respectively, per 100 parts of the ethylenically unsaturated monomers.

A small amount of a solvent; e.g., methyl ethyl ketone, acetone, trichlorotrifluoroethane, methyl isobutyl ketone, dimethyl sulfoxide, toluene, dibutyl phthalate, methylpyrrolidone, ethyl acetate, alcohols, cellosolves, and carbitols, may be used in the emulsion polymerization, as required. They are used within a limit not damaging the processability, working and environmental safety, and security of manufacturing. Alcohols and carbitols are preferable solvents. The amount of solvent used is approximately 0 to 10 parts by weight per 100 parts of the ethylenically unsaturated monomers.

The emulsion polymerizations may be carried out according to conventional methods, for example, a method in which all monomers are fed to a reaction system at one time, or a method in which after reacting a part of the remaining monomers are fed successively or separately, or a method in which each monomer is continuously fed. In any method, it is desirable to keep the rate of polymerization in the course of the reaction over 85%, or over 90%. The final polymerization conversion rate of copolymers in the polymerization reaction may be 90 to 100% by weight, or from 95 to 100% by weight.

A latex may also contain other additives known in latex compositions, and may use other emulsion polymerization or blending methodology such as disclosed in U.S. Pat. No. 5,371,148, incorporated here by reference.

5 In the case where the seed polymerization method is used, an advisable method is preparing seed particles of copolymers in advance by the emulsion copolymerization of monomers, and then adding a mixture of the monomers consisting of components (A)-(C) to the seed particles for the emulsion copolymerization.

10

A glass-transition temperature (T_g) of the copolymer may be varied depending on the desired application and is generally from $-20\text{ }^{\circ}\text{C}$ to about $80\text{ }^{\circ}\text{C}$,

15 An average particle diameter of the copolymer is from about 25 to about 2,000 angstroms.

Coating compositions

20

The coating compositions of the invention may be coated onto a substrate and cured using techniques known in the art (e.g., by spray-applying 3 to 4 mils of wet coating onto a metal panel, and heating in a $150\text{ }^{\circ}\text{C}$. forced air oven for 30 minutes). The substrate can be any common substrate such as paper, polyester films such as polyethylene and polypropylene, metals such as aluminum and steel, glass, urethane elastomers and primed (painted) substrates, and the like. The coating composition of the invention may be cured at room temperature (ambient cure), at elevated temperatures (thermal cure), or photochemically cured.

30

A coating composition of the invention may further contain coating additives. Examples of such coating additives include, but are not limited to, one or more leveling, rheology, and flow control agents such as silicones, fluorocarbons or cellulose; extenders; reactive coalescing aids such as those described in U.S. Pat. No. 5,349,026, incorporated herein by reference; plasticizers; flattening agents; pigment wetting and dispersing agents and surfactants; ultraviolet light (UV) absorbers; hindered amine light stabilizers (HALS); phosphites, tinting pigments; colorants; defoaming and antifoaming agents; anti-settling, anti-sag and bodying agents; anti-skinning agents; anti-flooding and anti-floating agents; biocides, fungicides and mildewcides; corrosion inhibitors; thickening agents; or coalescing agents. Specific examples of such additives can be found in Raw Materials Index, published by the National Paint & Coatings Association, 1500 Rhode Island Avenue, N.W., Washington, D.C. 20005. Further examples of such additives and emulsion polymerization methodology may be found in U.S. Pat. No. 5,371,148, incorporated herein by reference.

Examples of flattening agents include, but are not limited to, synthetic silica, available from the Davison Chemical Division of W. R. Grace & Company under the SYLOID® tradename; polypropylene, available from Hercules Inc. under the HERCOFLAT® tradename; and synthetic silicate, available from J. M. Huber Corporation under the ZEOLEX® tradename.

Examples of dispersing agents and surfactants include, but are not limited to, sodium bis(tridecyl)sulfosuccinnate, sodium di(2-ethylhexyl)sulfosuccinnate, sodium dihexylsulfosuccinnate, sodium dicyclohexylsulfosuccinnate, sodium diamylsulfosuccinnate, sodium diisobutylsulfosuccinnate, disodium iso-decylsulfosuccinnate, the disodium ethoxylated alcohol half ester of sulfosuccinnic acid, disodium alkylamidopolyethoxy sulfosuccinnate, tetra-sodium N-(1,2-dicarboxyethyl)-

N-octadecyl sulfosuccinamate, disodium N-octasulfosuccinamate, sulfated ethoxylated nonylphenol, 2-amino-2-methyl-1-propanol, and the like.

5 Examples of viscosity, suspension, and flow control agents include, but are not limited to, polyaminoamide phosphate, high molecular weight carboxylic acid salts of polyamine amides, and alkylene amine salts of an unsaturated fatty acid, all available from BYK Chemie U.S.A. under the ANTI TERRA® tradename. Further examples include polysiloxane copolymers,
10 polyacrylate solution, cellulose esters, hydroxyethyl cellulose, hydrophobically-modified hydroxyethyl cellulose, hydroxypropyl cellulose, polyamide wax, polyolefin wax, carboxymethyl cellulose, ammonium polyacrylate, sodium polyacrylate, hydroxypropyl methyl cellulose, ethyl hydroxyethyl cellulose, polyethylene oxide, guar gum and the like. Other
15 examples of thickeners include the methylene/ethylene oxide associative thickeners and water-soluble carboxylated thickeners such as, for example, UCAR POLYPHOBE® by Union Carbide.

Several proprietary antifoaming agents are commercially available and
20 include, for example, BUBREAK® of Buckman Laboratories Inc., BYK® (of BYK Chemie, U.S.A., FOAMASTER® and NOPCO® of Henkel Corp./Coating Chemicals, DREWPLUS® of the Drew Industrial Division of Ashland Chemical Company, TRYSOL® and TROYKYD® of Troy Chemical Corporation, and SAG® of Union Carbide Corporation.

25 Examples of fungicides, mildewcides, and biocides include, but are not limited to, 4,4-dimethyloxazolidine, 3,4,4-trimethyloxazolidine, modified barium metaborate, potassium N-hydroxy-methyl-N-methyldithiocarbamate, 2-(thiocyano-methylthio)benzothiazole, potassium dimethyl
30 dithiocarbamate, adamantane, N-(trichloromethylthio)phthalimide, 2,4,5,6-

tetrachloro-isophthalonitrile, orthophenyl phenol, 2,4,5-trichlorophenol, dehydroacetic acid, copper naphthenate, copper octoate, organic arsenic, tributyl tin oxide, zinc naphthenate, and copper 8-quinolate.

5 Examples of ultraviolet light absorbers are single compounds or mixtures of
compounds that absorb light in the range of 250-400 nm with a minimal
absorbance between 400 and 700 nm. Preferred examples are triazines,
cyanoacrylates, benzotriazoles, naphthalenes, benzophenones, and
10 benzoxazin-4-ones. More preferred are commercially available UV-
absorbers such as: Cyasorb UV-9 (Cytec Industries, CAS# 131-57-7),
Cyasorb UV-24 (Cytec Industries, CAS# 131-53-3), Cyasorb UV-531 (Cytec
Industries, CAS# 1843-05-6); Cyasorb UV-2337 (Cytec Industries, CAS#
25973-55-1), Cyasorb UV-5411 (Cytec Industries, CAS# 3147-75-9),
Cyasorb UV-5365 (Cytec Industries, CAS# 2440-22-4), Cyasorb UV-1164
15 (Cytec Industries, CAS# 2725-22-6), Cyasorb UV-3638 (Cytec Industries,
CAS# 18600-59-4), Tinuvin 213 (Ciba Specialty Chemicals, CAS# 104810-
47-1), Tinuvin 234 (Ciba Specialty Chemicals, CAS# 70321-86-7), Tinuvin
320 (Ciba Specialty Chemicals, CAS# 3846-71-7), Tinuvin 326 (Ciba
Specialty Chemicals, CAS# 3896-11-5), Tinuvin 327 (Ciba Specialty
20 Chemicals, CAS# 3864-99-1), Tinuvin 328 (Ciba Specialty Chemicals,
CAS# 25973-55-1), Tinuvin 329 (Ciba Specialty Chemicals, CAS# 3147-75-
9), Tinuvin 350 (Ciba Specialty Chemicals, CAS# 36437-37-3), Tinuvin 360
(Ciba Specialty Chemicals, CAS# 103597-45-1), Tinuvin 571 (Ciba
Specialty Chemicals, CAS# 23328-53-2) and Tinuvin 1577 (Ciba Specialty
25 Chemicals, CAS# 147315-50-2). Additional suitable UV absorbers are
listed in the Plastic Additives Handbook 5th Edition (Hanser Gardner
Publications, Inc., Cincinnati, OH, USA, 2001). It is obvious that identical
molecules sold under different trade names are covered by this invention. It
is obvious that combinations of UV absorbers can be used.

Examples of hindered amine light stabilizers (HALS) that may be suitable include, but are not limited to, Cyasorb UV-3346 (Cytec Industries, CAS# 90751-07-8), Cyasorb UV-3529 (Cytec Industries, CAS# 193098-40-7), Cyasorb UV-3641 (Cytec Industries, CAS# 106917-30-0), Cyasorb UV-3581 (Cytec Industries, CAS# 79720-19-7), Cyasorb UV-3853 (Cytec Industries, CAS# 167078-06-0), Cyasorb UV-3853S (Cytec Industries, CAS# 24860-22-8), Tinuvin 622 (Ciba Specialty Chemicals, CAS# 65447-77-0), Tinuvin 770 (Ciba Specialty Chemicals, CAS# 52829-07-9), Tinuvin 144 (Ciba Specialty Chemicals, CAS# 63843-89-0), Tinuvin 123 (Ciba Specialty Chemicals, CAS# 129757-67-1), Chimassorb 944 (Ciba Specialty Chemicals, CAS# 71878-19-8), Chimassorb 119 (Ciba Specialty Chemicals, CAS# 106990-43-6), Chimassorb 2020 (Ciba Specialty Chemicals, CAS# 192268-64-7), Lowilite 76 (Great Lakes Chemical Corp., CAS# 41556-26-7), Lowilite 62 (Great Lakes Chemical Corp., CAS# 65447-77-0), Lowilite 94 (Great Lakes Chemical Corp., CAS# 71878-19-8), Uvasil 299LM (Great Lakes Chemical Corp., CAS# 182635-99-0), and Uvasil 299HM (Great Lakes Chemical Corp., CAS# 182635-99-0), Dastib 1082 (Vocht a.s., CAS# 131290-28-3), Uvinul 4049H (BASF Corp., CAS# 109423-00-9), Uvinul 4050H (BASF Corp., CAS# 124172-53-8), Uvinul 5050H (BASF Corp., CAS# 199237-39-3), Mark LA 57 (Asahi Denka Co., Ltd., CAS# 64022-61-3), Mark LA 52 (Asahi Denka Co., Ltd., CAS# 91788-83-9), Mark LA 62 (Asahi Denka Co., Ltd., CAS# 107119-91-5), Mark LA 67 (Asahi Denka Co., Ltd., CAS# 100631-43-4), Mark LA 63 (Asahi Denka Co., Ltd. Co., Ltd. Co., CAS# 115055-30-6), Mark LA 68 (Asahi Denka Co., Ltd., CAS# 100631-44-5), Hostavin N 20 (Clariant Corp., CAS# 95078-42-5), Hostavin N 24 (Clariant Corp., CAS# 85099-51-1, CAS# 85099-50-9), Hostavin N 30 (Clariant Corp., CAS# 78276-66-1), Diacetam-5 (GTPZAB Gigiena Truda, USSR, CAS# 76505-58-3), Uvasorb-HA 88 (3V Sigma, CAS# 136504-96-6), Goodrite UV-3034 (BF Goodrich Chemical Co., CAS# 71029-16-8), Goodrite UV-3150 (BF Goodrich Chemical Co., CAS# 96204-

36-3), Goodrite UV-3159 (BF Goodrich Chemical Co., CAS# 130277-45-1), Sanduvor 3050 (Clariant Corp., CAS# 85099-51-0), Sanduvor PR-31 (Clariant Corp., CAS# 147783-69-5), UV Check AM806 (Ferro Corp., CAS# 154636-12-1), Sumisorb TM-061 (Sumitomo Chemical Company, CAS# 84214-94-8), Sumisorb LS-060 (Sumitomo Chemical Company, CAS# 99473-08-2), Uvasil 299 LM (Great Lakes Chemical Corp., CAS# 164648-93-5), Uvasil 299 HM (Great Lakes Chemical Corp., CAS# 164648-93-5), Nylostab S-EED (Clariant Corp., CAS# 42774-15-2). Additional hindered amine light stabilizer may be listed in the Plastic Additives Handbook 5th Edition (Hanser Gardner Publications, Inc., Cincinnati, OH, USA, 2001).

Examples of phosphites include, but are not limited to, compounds sold under the following brand names: Irgafos TNPP (Ciba Specialty Chemicals, CAS# 26523-78-4), Irgafos 168 (Ciba Specialty Chemicals, CAS# 31570-04-4), Ultrinox 626 (GE Specialty Chemicals, CAS# 26741-53-7), Mark PEP 36 (Asahi Denka Co., Ltd., CAS# 80693-00-1), Mark HP-10 (Asahi Denka Co., Ltd., CAS# 140221-14-3), Irgafos P-EPQ (Ciba Specialty Chemicals, CAS# 38613-77-3), Sandostab P-EPQ (Clariant Corp., CAS# 119345-01-6), Ethanox 398 (Albemarle Corp., CAS# 118337-09-0), Weston 618 (GE Specialty Chemicals, CAS# 3806-34-6), Irgafos 12 (Ciba Specialty Chemicals, CAS# 80410-33-9), Irgafos 38 (Ciba Specialty Chemicals, CAS# 145650-60-8), Ultrinox 641 (GE Specialty Chemicals, CAS# 161717-32-4), Doverphos S-9228 (Dover Chemical Corp. CAS# 154862-43-8) and the like.

Examples of solvents and coalescing agents are well known and include, but are not limited to, ethanol, n-propanol, isopropanol, n-butanol, sec-butanol, isobutanol, ethylene glycol monobutyl ether, propylene glycol n-butyl ether, propylene glycol methyl ether, propylene glycol monopropyl ether, dipropylene glycol methyl ether, diethylene glycol monobutyl ether,

2,2,4-trimethyl-1,3-pentanediol mono-isobutyrate, ethylene glycol mono-octyl ether, diacetone alcohol, and the like. Such solvents and coalescing aids may also include reactive solvents and coalescing aids such as diallyl phthalate, SANTOLINK XI-100® (polyglycidyl allyl ether from Monsanto),
5 and others as described in U.S. Pat. Nos. 5,349,026 and 5,371,148, incorporated herein by reference.

Thus, one embodiment of the present invention provides a polymer composition having copolymerized therein, in an amount sufficient to
10 improve the apparent whiteness of a coating composition containing the polymer composition, at least one blue 1,4-bis(2,6-dialkylanilino)anthraquinone compound of Formula (I) plus at least one red or violet anthraquinone or anthrapyridone compound of formulae (II)-(X) or a single dye compound of formula XI, above, or XI optionally mixed with red
15 or violet compounds of formulae II-X. In this regard, the dyes used in either the two component toner system or one component toner system will not be present in an amount sufficient to impart a substantial amount of color to the polymer.

20 The single-component or two-component toner system of the present invention can be added before polymerization or during polymerization of a toner polymer. Accordingly, as a further aspect of the present invention, there is provided a premix composition comprising a blend of at least one blue 1,4-bis(2,6-dialkylanilino)anthraquinone compound of formula (I), along
25 with at least one red or violet anthraquinone or anthrapyridone compound of formulae (II)-(X) above, or a premix with reddish-blue anthrapyridone XI combined with at least one red or violet compound of formulae II-X. The premix composition may be a neat blend of the red or violet and the blue compounds, or the composition may be pre-dissolved in one of the
30 polyester's monomeric species, e.g., ethylene glycol.

The total weight of toner polymer added to the coating may depend, of course, on the amount of yellow color that is to be toned and the weight percent of the dye that is copolymerized into the toner polymer. Generally, the toner polymer is added in amounts such that a maximum concentration of about 350 ppmw (parts per million by weight) of total toner dyes that were copolymerized into the toner polymer is delivered to the coating. More preferred are coating compositions that contain an amount of toner polymer such that about 10-90 ppmw of blue component (I) in combination with about 10-100 ppmw of red or violet components of formulae (II-X) or 10-100 ppmw of reddish-blue component XI in combination with about 0-75 ppmw of red or violet components of formulae (II-X) is delivered to the coating. The present invention is not intended for applications such as inks or other thin, intensely colored coatings.

An embodiment of the present invention is an alkyd resin composition having copolymerized therein at least one of the toner dyes disclosed herein.

Another embodiment of the present invention is a coating composition that contains at least one of the toner polymer compositions disclosed herein.

Another embodiment of the present invention is a coating composition that contains at least one latex polymer and at least one of the water-dispersible toner polymer compositions disclosed herein.

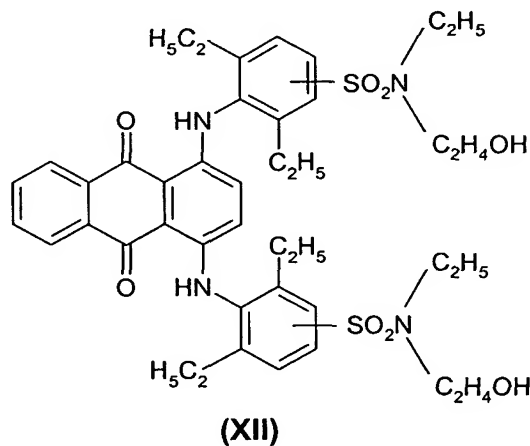
Another embodiment of the present invention is a paint formulation that contains at least one of the water-dispersible toner polymer compositions disclosed herein.

Another embodiment of the present invention is a paint formulation that contains at least one latex polymer and at least one of the water-dispersible toner polymer compositions disclosed herein.

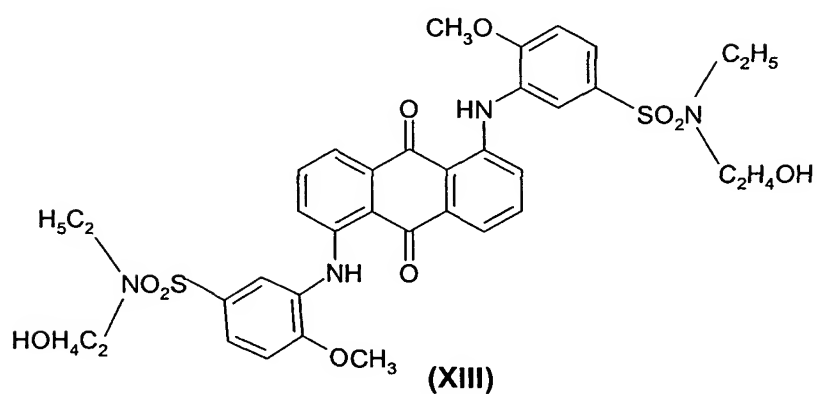
- 5 Another embodiment of the present invention is a process to improve the apparent whiteness of a coating composition that contains water or polar solvents such as methanol, ethanol, or the like, by adding at least one of the water-dispersible toner polymer compositions disclosed herein.
- 10 Another embodiment of the present invention is a process to improve the apparent whiteness of a coating composition that contains at least one latex polymer and at least one water-dispersible toner polymer disclosed herein. In one embodiment, the water-dispersible toner polymer composition can be added as a surfactant during polymerization of the latex polymer. In
- 15 another embodiment, the water-dispersible toner polymer composition(s) is added to a water-containing coating formulation, such as a paint, that contains a latex polymer. In yet another embodiment, the toner dyes disclosed herein are polymerized into the water-dispersible polyester at a level of up to about 30,000 ppmw (parts per million by weight) thereby
- 20 serving as a concentrate to be added to coating formulations. In general, the concentrate would be added to a coating in an amount sufficient to deliver up to about 300 ppmw of the toner dye.
- In another embodiment, the blue anthraquinone compound corresponds to
- 25 structure (I) above, wherein R is hydrogen; R₁ and R₂ are independently selected from methyl and ethyl; R₃ is hydrogen, methyl, or bromo; R₄ is hydrogen, C₁-C₄-alkyl or aryl; R₅ is selected from the group consisting of C₁-C₆-alkylene, C₂-C₄-alkylene[-O- C₂-C₄-alkylene]₁₋₂, -CH₂C₆H₁₀CH₂-, arylene, or -CH₂-arylene- and the red component corresponds to formula

(V), wherein R_7 is C_1 - C_6 -alkoxy and R_4 and R_5 are as defined above for the preferred blue component (I).

In another embodiment of the present invention, the blue compound of
5 formula (I) is

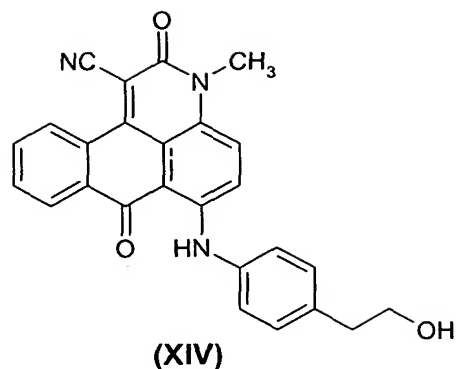


and the red or violet compound of formula (V) is

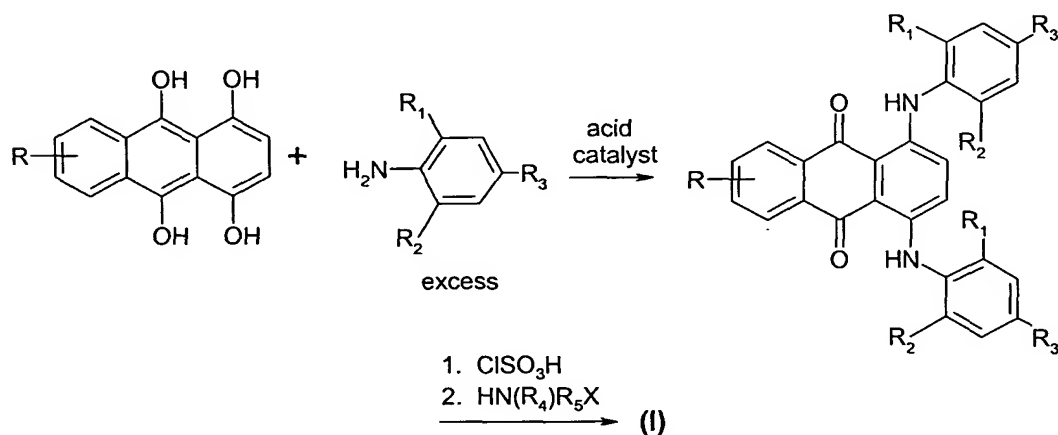


10

and the reddish-blue compound of formula (XI) is



The blue anthraquinones of formula (I) can be prepared, in general, by reaction of leucoquinizarin (1,4,9,10-tetrahydroxyanthracene) compounds
 5 with an excess aromatic amines, preferably in the presence of acid catalysts such as boric acid, as described in U.S. Pat. No. 3,918,976, incorporated herein by reference, and as follows:



10 The 1,4-bis(2,6-dialkylanilino)anthraquinone compounds thus produced are readily functionalized, if needed, by first chlorosulfonating with chlorosulfonic acid to produce di-sulfonyl chlorides which can be reacted with amines containing polyester reactive groups, the general method being disclosed in U.S. Pat. No. 2,731,476, incorporated herein by reference.

Typical amines corresponding to formula $\text{HN}(\text{R}_4)\text{R}_5\text{X}$ include 2-aminoethanol, 2,2-iminodiethanol, 1-amino-2,3-propanediol, 2-methylaminoethanol, 2-ethylaminoethanol, 2-anilinoethanol, methyl anthranilate, methyl *m*-amino benzoate, *p*-aminobenzoic acid, *m*-aminophenol, 6-aminohexanoic acid, .beta.-alanine, glycine ethyl ester, 2-(*p*-aminophenyl)ethanol, 2-(*p*-aminophenoxy)ethanol 4-aminomethylcyclohexane methanol and 3-amino-2,2-dimethyl-1-propanol.

Red or violet compounds (II) can be prepared by reacting 1,5-dichloroanthraquinone and/or 1,8-dichloro-anthraquinone or mixtures thereof with *o*-, *m*- and *p*-aminobenzoic acids (and esters thereof) by a modified Ullmann reaction involving nitrogen arylation of the anilines in the presence of copper catalysts (see U.S. Pat. No. 4,359,580, incorporated herein by reference).

Red or violet compounds of formula (III) can be prepared as described in U.S. Pat. No. 4,420,581, and compounds of formula (VI) can be prepared as in U.S. Pat. No. 4,999,418, both of which are incorporated herein by reference.

Red or violet anthraquinone compounds of formula (IV) can be prepared by reacting 1,5-dichloroanthraquinone and 1,8-dichloroanthraquinone or mixtures thereof with substituted benzyl amines by procedures similar to those used in preparing compounds of formulae (III) and (VI).

Red or violet anthrapyridone compounds (VII) can be prepared as disclosed in U.S. Pat. No. 4,790,581, incorporated herein by reference; procedures useful in preparing red or violet anthrapyridone compounds (VIII) and (IX) are disclosed in U.S. Pat. Nos. 4,745,174 and 4,470,581, incorporated herein by reference.

Reddish-blue anthrapyridone compounds of Formulae XI are prepared as described in U.S. Pat. Nos. 4,745,174 and 5,340,910.

5 This invention can be further illustrated by the following examples of preferred embodiments, although it will be understood that these examples are included merely for purposes of illustration and are not intended to limit the scope of the invention unless otherwise specifically indicated.

10

EXAMPLES

Examples 1-4 (Preparation of water-dispersible alkyd resins).

15

Step 1: An adduct of neopentyl glycol (NPG) and 5-sodiosulfoisophthalic acid (SSIPa) was first prepared by reacting NPG (2483.5 g, 23.88 mol); SSIPa (93.3%) (1608.5 g, 5.6 mol); distilled water (276.0 g); and the catalyst, FASCAT 4100 (3.3 g, Atofina Chemicals) in a three-neck, round
20 bottom flask equipped with a mechanical stirrer, a steam-jacketed partial condenser, a Dean-Stark trap, a nitrogen inlet, and a water condenser. The reaction temperature was gradually increased from 130°C to 190°C in a period of five hours and the condensate (water) collected in a Dean-Stark trap. The reaction was allowed to continue until an acid number of 3 was
25 obtained. A portion of the resultant product was used in the following step.

Step 2: Into a three-neck, round-bottom flask (3L) equipped with the same configuration as above were charged the NPG/SSIPa adduct (303.3 g); trimethylol propane (TMP) (456.0 g); isophthalic acid (594.0 g); PAMOLYN
30 200 (684.0 g, tall oil fatty acid, Eastman Chemical Company, Kingsport, TN); the toner dyes and levels as reported in Table 1, for Examples 2, 3

and 4, respectively; and FASCAT 4100 (1.8 g, Atofina Chemicals).
(Example 1 was provided as a control and contained no toner dye.) The
reaction temperature was gradually increased to 220°C over one hour. The
reaction was allowed to continue for about three more hours until an acid
number of 8 was obtained. The resulting resin was allowed to cool to a
temperature of 140°C. Propylene glycol propyl ether (PnP) (615.0 g) was
added and the product was held at 90°C for 90 minutes and allowed to cool
to room temperature.

The finished product was fairly free flowing at room temperature. There
were no signs of any color separation in any of the products after 6 months.

Table 1. Dye type and amount for each of the examples

Example	Dye Structure	mass
1	N/A	0
2	XIII	2.0 g
3	XII	2.0 g
4	XII, XIII	10.0 g each
5	XIII	13.60 g (5 wt%)
6	XII	13.60 g (5 wt%)
7	XIII	1.36 g (0.5 wt%)
8	XII	1.36 g (0.5 wt%)

Examples 5-8 (Water-dispersible polyesters with co-polymerized toner
dyes).

Water-dispersible polymer (1mole) was prepared in the laboratory by the
following technique. A polymer was prepared, with acid components
consisting of 82 mole % isophthalic acid and 18 mole % 5-
sodiosulfoisophthalic acid, a mixture of diol components consisting of 54

mole % diethylene glycol and 46 mole % 1,4-cyclohexanedimethanol (cis/trans ratio of about 35/65). The following were weighed directly into a 500 ml roundbottom flask or were weighed and transferred:

- 5 136.1 g (0.82 mole) isophthalic acid
- 53.28 g (0.18 mole) 5-sodiosulfoisophthalic acid
- 114.48 g (1.08 mole) diethylene glycol
- 72.86 g (0.51 mole) 1,4-cyclohexanedimethanol
- 1.48 g (0.018 mole) anhydrous sodium acetate
- 10 Toner dye and mass listed in Table 1 (Examples 5-8, respectively)
- 100 ppmw titanium tetraisopropoxide catalyst

A stainless steel stirrer shaft and blade were used to stir the system to facilitate reaction and removal of volatiles. A Belmont metal bath placed in a heating mantle connected to a temperature controller was used as the heating medium. The system was purged with nitrogen and kept under an N₂ blanket during the run. Dry ice traps were used to collect volatiles. An oil-based vacuum pump was used to place the system under reduced pressure for molecular weight buildup after the esterification stage.

20 The bath was heated to 200°C and the flask and contents were inserted in the bath and stirred for 60 minutes. The temperature was increased to 210 °C and held for 60 minutes. The temperature was then increased to 275 °C and held for 20 minutes. The system was placed under vacuum and held at 0.2 mm torr for 90 minutes. The system was returned to the nitrogen purge, the polymer was cooled and removed from the flask and ground. The polymer had an I.V. (inherent viscosity in 60/40 phenol/tetrachloroethane) of 0.327. Analysis by nuclear magnetic resonance spectroscopy (NMR) showed a composition of 17 mole % 5-sodiosulfoisophthalic acid, 54.3 mole % isophthalic acid, and 45.5 mole % 1,4-cyclohexanedimethanol and 53.5

mole % diethylene glycol. The polymer had a second cycle glass transition temperature of 60 °C by differential scanning calorimetry (DSC).

5 A portion (30.0 g) of the toner dye/sulfo-containing water-dispersible polymer was added to distilled water (70.0 g) at about 80 °C. Good dispersion of the polymer was achieved by stirring and heating to 100 °C. The final dispersion showed no signs of particle settling. This dispersion was then used as an additive for toning resins, as further discussed below.

10 Example 9 (Preparation of a waterborne latex containing 28% acrylonitrile).

To a 4 L jacketed reaction kettle equipped with a condenser, nitrogen purge, and stirrer, 1840 g of water and 12.0 g of 30% Disponil FES 32 (surfactant, Henkel Technologies), were added. A waterborne seed latex
15 having an average particle size of 40 nm (201.0 g) was then added to the reactor along with EDTA 1% solution (1.0 g) and iron II sulfate 1% solution (1.0 g). The content of the reactor was heated to 55 °C. In a separate 2000 ml flask, a monomer mix of 666.0 g of styrene, 540.0 g of 2-ethylhexyl acrylate, 504.0 g of acrylonitrile, and 90.0 g of methacrylic acid was
20 prepared. In a separate 250 ml flask, a surfactant mixture of 30% Disponil FES 32 (48.0 g) and distilled water (72.0g) was prepared. The monomer mix was then pumped into the heated reactor over a 3-hour period. As the monomer feed was started, 7.0 g t-butyl hydroperoxide (70%) in 153 g of distilled water and (1.0 g) of sodium carbonate, EDTA 1% solution (1.0 g)
25 and iron II sulfate 1% solution (1.0 g), and isoascorbic acid 6.0 g dissolved in 150.0 g of distilled water were fed into the reaction over a 6 hour period. The surfactant/water mix was pumped into the reaction over a 2-hour period beginning with the monomer feed. After all the initiator was added, the reaction was held at 55 °C for an additional one half hour at which point the
30 reactor was cooled to 30 °C.

5 The resulting emulsion was filtered through a 100-mesh screen. The emulsion contained 43.9% solids and the particle size was 131 nm as measured by dynamic light scattering. Viscosity was 145 cp and the Tg was 70.2 °C.

Examples 10-16. Waterborne latexes toned with water-dispersed alkyd resins having toner dyes copolymerized therein.

10 Table 2. (Toned Waterborne Latexes)

Example	Water dispersible alkyd resin	Description	Red toner dye (XIII) ppm	Blue toner dye (XII) ppm	Lab b* value
10	---	White Leneta Chart	---	---	2.8
11	Example 1	Control	---	---	9.9
12	Examples 1,3	Blue Toner	---	20	5.2
13	Examples 1,2,3	Blue/Red Toner Blend	10	50	5.9
14	Examples 1,2,3	Blue/Red Toner Blend	25	13	2.9
15	Examples 1,2,3	Blue/Red Toner Blend	20	20	5.3
16	Examples 1,2,3	Blue/Red Toner Blend	60	60	2.7

15 The color of the sample was determined in a conventional manner using a HunterLab UltraScan Colorimeter manufactured by Hunter Associates Laboratory, Inc., Reston, Virginia. The instrument is operated using HunterLab Universal Software (version 3.8). Calibration and operation of the instrument is according to the HunterLab User Manual, incorporated herein by reference, and is largely directed by the Universal Software. To reproduce the results on any colorimeter, run the instrument according to its

instructions and use the following testing parameters: D65 Light Source (daylight, 6500°K color temperature), Reflectance Mode, Large Area View, Specular Included, CIE 10° Observer, Outputs are CIE L*, a*, b*. An increase in the positive b* value indicates yellowness, while a decrease in the numerical value of b* indicates a reduction in yellowness. Color measurement and practice are discussed in greater detail in Anni Berger-Schunn in *Practical Color Measurement*, Wiley, NY pages 39-56 and 91-98 (1994).

10 The CIE L*, a*, b* color measurement method was used to determine the color of the latex formulations of Examples 12 - 16 in Table 2 as compared to the latex control (Example 10) and the white Leneta chart (Example 10). The latex resins of Examples 12-16 were prepared by blending the water-dispersible polymer from Examples 1, 2, or 3, as indicated, with a non-toner-containing latex resin (prepared according to example 9) to provide an amount of toner dye sufficient to reduce the b* color value (Table 2). Films were prepared from the toner-containing latex resins, and were drawn down on a white Leneta chart to about a 1 mil thickness (dry). The films were baked to dryness at 60 °C for 90 minutes. After cooling, the b* color was measured by standard procedures.

25 It is clear from the data in Table 2 that the b* color (yellowness) was reduced in the inventive examples containing both a latex and the water-dispersed resins having toner dyes (XII and XIII) copolymerized therein, thereby improving the apparent whiteness of the latexes. The data also show that the b* color of the latex could be reduced, according to the invention, to less than the b* value for the uncoated substrate .

Examples 17-19. Acrylonitrile-containing latexes toned with water-dispersed polyester resins having toner dyes polymerized therein.

Table 3 (Acrylonitrile-containing Latex)

Example	Water Dispersible Polyester Resin	Description	Red toner dye (XIII) ppm	Blue toner dye (XII) ppm	Lab b* value
10		White Leneta Chart	---	---	2.8
17	Example 9	Control	---	---	5.3
18	Examples 5,6,9	Blue/Red Toner Blend	30	30	2.8
19	Examples 5,6,9	Blue/Red Toner Blend	60	60	1.1

5

The samples for Examples 18 and 19 (Table 3) were prepared by blending the water-dispersible polyester resins of Examples 5 and 6 (Table 3) with the resin of Example 9 having 28% acrylonitrile co-polymerized in the resin, to achieve the approximate desired levels of toner dye. When the appropriate levels of toner dye were added, clear films were drawn down on white Leneta chart at about 1 mil thick (dry). These films were then baked at 60 °C for 90 minutes. After cooling, the yellowness of each film was measured and recorded as a b* value. It is clear from the data in Table 3 that the b* color was reduced in the examples containing toner dye, thereby improving the apparent whiteness, by adding the water-dispersible polymer compositions that contained co-polymerizable toner dyes (XII and XIII). The data also show that the b* color of the latex could be reduced to a value less than that of the uncoated substrate (see Example 18). Addition of even more toner dye-containing water-dispersible polymer led to a coating that had a b* value lower than the uncoated Leneta chart substrate (see Example 19).

10

15

20

Example 20 (Preparation of a latex formulation).

To a 2 L jacketed reaction kettle equipped with a condenser, nitrogen purge, and stirrer, 202.3 g of water and 7.1 g of 18% Hitenol BC-20 (a polymerizable surfactant manufactured by DKS International), were added. The contents of the reactor were heated to 85°C. In a 2000 ml flask, a monomer/surfactant pre-emulsion of 84.5 g of methyl methacrylate, 305.9 g of styrene, 17.0 g of methacrylic acid, 127.4 g of 2-acetoacetoxyethyl methacrylate, 314.4 g of butyl acrylate, 0.4 g of 2-hydroxyethyl methacrylate, 3.4 g of iso-octylmercaptopropionate, 1.7 g of ammonium carbonate, 500.3 g of water, and 75.5 g of Hitenol BC-20 (18%) was prepared with rapid stirring. The resulting pre-emulsion was stable. A portion of the pre-emulsion mix (57.2 g) was added to the heated reactor. After allowing the contents of the reactor to re-equilibrate, 1.27 g of ammonium persulfate dissolved in 18.4 g of water was added to the reactor. The reaction was allowed to stir at temperature for 15 minutes. The remaining pre-emulsion mix was fed into the reactor over a period of 250 minutes. During the same time period, a solution of 2.6 g of ammonium persulfate and 1.7 g of ammonium carbonate dissolved in 55.1 g of distilled water was fed into the reactor. After all the monomer was added, the reaction was held at 85°C for an additional one-half hour at which point the reactor was cooled to 65°C. Additional feeds consisting of 3.6 g of t-butyl hydroperoxide (70%) in 18.4 g of distilled water and 2.6 g of sodium formaldehyde sulfoxylate dissolved in 18.4 g of distilled water were fed into the reaction over a 15-minute period. The reaction mixture was allowed to cool to room temperature with stirring. Ammonium hydroxide (36.4 g of 28% aqueous solution) was then stirred into the reaction mixture. Proxel GXL (1.7 g, a biocide supplied by Avecia Inc.) was added, with stirring, followed by the addition of 2.0 weight %, based upon the total weight of the reaction mixture, of polyethylene imine.

The resulting emulsion was filtered through a 100-mesh screen. The emulsion contained 48.9% solids and the particle size was 129 nm as measured by dynamic light scattering. The final emulsion was a uniform light yellow color with no signs of particle settling.

Examples 21-33 Water-dispersible polyesters with copolymerized toner dyes in paint formulations.

The procedure described herein was used to the prepare the paint formulations listed as examples in Table 4. The following materials were ground together: water (44.1 g), 28% NH_4OH (0.6 g), Surfynol CT131 (4.5 g, supplied by Air Products and Chemicals, Inc.), Surfynol 104DPM (1.2 g, supplied by Air Products and Chemicals, Inc.), Surfynol DF210 (0.35 g, supplied by Air Products and Chemicals, Inc.), BYK-025 (0.90 g, supplied by BYK Chemie), Ti-706 (148.5 g), 20% Acrysol QR-708 (0.14 g, supplied by Rohm and Haas Company). The ground material (105.8 g) was mixed with the following materials: the latex of Example 20 (240.6 g), 28% NH_4OH (0.60 g), 15% sodium nitrite (3.1g), BYK-025 (0.80 g), dipropylene glycol n-butyl ether (DPnB/Texanol, Eastman) (14.0 /4.67g), 20% Acrysol QR-708 (1.5 g), water (8.0 g), and the water-dispersible polyester with copolymerized toner dyes listed in Table 4. The paints were drawn down on aluminum substrates so as to achieve a final film thickness of approximately 1 mil. The samples were allowed to air dry for 25 minutes and were then baked in a forced air oven at 300 °F for an additional 25 minutes. The samples were then checked for total yellowness, which is recorded as the "b*" value (Table 4). The yellowness increases with higher "b*" values.

Table 4. (Water-dispersible polyesters with co-polymerized toner dyes in paint formulations)

Example	Water Dispersible Polyester Resin	Red toner dye (XIII) ppm	Blue toner dye (XII) ppm	Lab b* value
21	none	0	0	4.7
22	Example 5,6	100	180	-2.2
23	Example 5,6	60	30	1.44
24	Example 5,6	20	40	2.2
25	Example 5,6	30	60	1.0
26	Example 5,6	120	120	-2.3
27	Example 5,6	70	70	0.5
28	Example 5,6	20	30	2.34
29	Example 5,6	90	75	-0.1
30	Example 5,6	150	150	-2.3
31	Example 5,6	100	150	-1.85
32	Example 5,6	150	100	-1.6
33	Example 5,6	100	200	-2.7

5 It is clear from the data in Table 4 that the water-dispersible polymers that contained co-polymerizable toner dyes were effective at improving the apparent whiteness of latex paint formulations. The loading of red and blue toner dye-containing water-dispersible polymer was varied to reduce the b* color value to approximately 0 (Example 29). Negative b* color values (slightly blue) were obtained by further addition of the water-dispersible
10 polymers that contained co-polymerizable toner dyes (Examples 22, 26, 30, 31, 32 and 33).

The b* color data in Table 5 was obtained by measuring the b* color of painted aluminum panels that were exposed to UV light in a QUV device.

Each panel was painted using one of the latex paint formulations disclosed in Table 4 (Examples 21-33). The paints were drawn down on aluminum substrates so as to achieve a final film thickness of approximately 1 mil. The samples were allowed to air dry for 1 week and the yellowness was recorded. The panels were then placed in a QUV chamber. The b* color of each sample was measured and recorded after 550 h and 730 h of exposure.

Table 5. QUV Exposure of the Paint Formulations of Table 4

Example	b* color at 550 h exposure in a QUV	b* color at 730 h exposure in a QUV	Change in b* ¹
21	3.6	4.1	0.5
22	-0.7	-0.6	0.1
23	1.5	1.4	0.1
24	2.4	2.2	0.2
25	1.4	1.5	0.1
26	-0.9	-1.2	0.3
27	0.8	0.6	0.2
28	2.2	1.9	0.3
29	0.7	0.6	0.1
30	-1.0	-0.8	0.2
31	-0.7	-0.8	0.1
32	-0.6	-0.5	0.1
33	-1.2	-1.1	0.1

1. Change in b* = abs[abs(final b* value) - abs(initial b* value)]

The data in Table 5 show that latex paint formulations that contained water-dispersible polyesters with co-polymerized toner dyes were much less yellow (lower b* value) than a sample that did not contain toner polymer (see Example 21 - no toner polymer added). It was also surprisingly discovered that paint formulations that contained water-dispersible polyesters with co-polymerized toner dyes underwent less of a color change between 550 h of exposure and 730 h of exposure. It was surprising to

discover the reduction in yellowing and improvement in apparent whiteness that was obtained by using such very low levels of co-polymerizable toner dyes upon advanced exposure in a QUV device.

5 Example 34. Preparation of a Universal Alkyd Containing 1000 ppm of Dye XIV.

Step 1. A neopentyl glycol (NPG) / 5-sodiosulfoisophthalic acid (SIP) adduct was prepared by reacting neopentyl glycol (827.00 g, 7.95 mol), 5-
10 sodiosulfoisophthalic acid (536.00 g, 2.00 mol), water (91.90 g), and FASCAT 4100 (1.10 g-acid catalyst) in a three-neck, round-bottom flask equipped with a mechanical stirrer, a steam-jacketed partial condenser, a Dean-Stark trap, a nitrogen inlet, and a water condenser. The reaction temperature was gradually increased from 110-150 °C in a 45-min period
15 and the distillate collected in the Dean-Stark trap. The reaction was allowed to continue at 150-180 °C for 3 hr, and at 190 °C for 4.5 hr, until an acid number of 3.0 mg KOH/g was obtained. The reaction mixture was then allowed to cool to 80°C and water added to give an NPG/SIP adduct having 90% solids. A portion of the resultant product was used in the
20 following step.

Step 2. In a separate reactor equipped with the same configuration as above were charged pentaerythritol (PE) (42.86 g, 0.32 mol), diethylene glycol (DEG) (49.36 g, 0.47 mol), the above NPG/SIP adduct (90%, 164.00
25 g), adipic acid (AD) (85.52 g, 0.59 mol), PAMOLYN 200 (a high purity grade of linoleic acid derived wholly from a tall oil fatty acid, available from Eastman Chemical Company, Kingsport, TN) (423.18 g, 1.46 mol), dye XIV (0.765 g), and FASCAT 4100 (0.38 g). The mixture was allowed to react at 150-220 °C for about six hours until 64.0 g of the condensate (water) was
30 collected. The acid number was determined to be 11 mg KOH/g. The

mixture was then allowed to cool to 50°C and collected as 100% solids. The resulting purple alkyd was a liquid at room temperature; it was soluble in common organic solvents as well as dispersible in water (universal).

5 Example 35. Preparation of a Universal Alkyd Containing 1000 ppm of Red Toner Dye (XIII).

10 An alkyd containing 1000 ppm of a red toner dye (XIII) was prepared, according to the process described in Example 34, by replacing the reddish-blue dye with the red toner dye XIII.

15 Example 36. Preparation of a Universal Alkyd Containing 1000 ppm of Blue Toner Dye (XII).

15 An alkyd containing 1000 ppm of a blue toner dye (XII) was prepared, according to the process described in Example 34, by replacing the reddish-blue dye with the blue toner dye XII.

20 Example 37. Preparation of a Universal Alkyd Containing 500 ppm of Blue Toner Dye (XII) and 500 ppm of Red Toner Dye (XIII).

25 An alkyd containing 500 PPM of blue toner dye (XII) and 500 PPM of red toner dye (XIII) was prepared, according to the process described in Example 34.

25 Examples 38-40. Universal Alkyd with Dye XIV in Waterborne Paint Formulations.

30 The following materials were ground together: water (44.1 g), 28% NH₄OH (0.6 g), Surfynol CT131 (4.5 g), Surfynol 104DPM (1.2 g), Surfynol DF210

(0.35 g), BYK-025 (0.90 g), Ti-706 (148.5 g), 20% QR-708 (0.14 g). The ground material (105.8 g) was mixed with the following materials: the latex of Example 20 (240.6 g), 28% NH₄OH (0.60 g), 15% sodium nitrite (3.1g), BYK-025 (0.80 g), DPnB/Texanol (dipropylene glycol n-butyl ether/Texanol, Eastman) (14.0 /4.67g), 20% QR-708 (1.5 g), water (8.0 g) and the appropriate amount of the toner-containing alkyd of Example 34 to provide the amount of colorant listed in Table 6. The paints were drawn down on aluminum substrates so as to achieve a final film thickness of approximately 1 mil. The samples were allowed to air dry for 25 minutes and were then baked in a forced air oven at 300^oF for an additional 25 minutes. The samples were then checked for total yellowness, which is recorded as the "b*" value (Table 6). The yellowness increases with higher "b*" values.

Table 6. L*, a*, b* Color Values for Paint formulations

Example	# ppm colorant from adding the Alkyd Composition of Example 34	L*	a*	b*
38	0	96.7	-1.7	4.9
39	10 ppm colorant	95.6	-1.8	3.3
40	20 ppm colorant	94.4	-1.9	2.0

It is clear from the data in Table 6 that adding the alkyd composition of Example 34, having Dye XIV copolymerized therein, is useful for reducing the b* color, thus improving the apparent whiteness of the paint coating.

Example 41. Universal Alkyd with Reddish-Blue Toner Dye XIV in Solvent-Based Paint Formulation.

The following materials were ground together using a high-speed mixer: Duramac HS 57-5816 (80.0 g) (Eastman Chemical Co.), Mineral Spirits

Rule 66 (120.0g), Bentone SD-1 (Elementis) (10.4 g), Lecithin Yelkin TS (ADM) (2.0 g), Nuosperse 657 (Sasol Servo BV) (3.0 g), Irocthix 2000 (Lubrizol) (10.0 g), TiPure R-706 (Dupont) (270.0 g), and Barytes- Cimbar UF (Cimbar) (75.0 g). The ground material (570.4 g) was mixed with the following materials: Duramac HS 57-5816 (430.0 g), Mineral Spirits Rule 66 (45.0 g), 12% Cobalt Ten-Cem (OMG Americas) (2.8 g), 5% Calcium Ten-Cem (OMG Americas) (60.0 g), and Exkin #2 (Condea Servo) (2.0 g) to give a white paint formulation (1). To the paint formulation (1) (25.00 g) was added the universal alkyd colorant of Example 34 (0.78 g) and subsequently mixed to give an alkyd paint formulation (2) having improved whiteness.

Example 42. Universal Alkyds with Red Toner Dye XIII and Blue Toner XII in Solvent-Based Paint Formulations.

To the white paint formulation (1) (50.00 g) prepared in Example 41 was added a combination of the universal alkyd colorants, Examples 35 (0.78 g) and Example 36 (0.78 g), and subsequently mixed to give an alkyd paint formulation (3) having improved whiteness.

The above alkyd paint formulations (1, 2, and 3) were drawn down on aluminum substrates so as to achieve a final film thickness of approximately 1 mil. The samples were allowed to air dry for 25 minutes and were then baked in a forced air oven at 300^oF for an additional 25 minutes. The samples were then checked for total yellowness, which was recorded as the "b*" value (Table 7). The yellowness increases with higher "b*" values.

Table 7. b* Color Value for Paint formulations

Example	Added Colorant	b*, initial	b*, after one day	b*, after one week
41 (Formulation 1)	0	3.95	3.88	3.74
41 (Formulation 2)	40 ppm of Example 34	2.74	2.57	2.83
42 (Formulation 3)	20 ppm of Example 35 and 20 ppm of Example 36	2.01	2.37	2.28

5 The invention has been described in detail with particular reference to specific embodiments, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention. Although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being set forth in the following claims.